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THESIS

OPTICAL LASER TECHNOLOGY, SPECIFICALLY CD-ROM, AND ITS APPLICATION TO THE STORAGE AND RETRIEVAL OF INFORMATION

by

David J. Lind

June 1987

Thesis Advisor: Barry Frew

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One of the significant problems of this "information age" is the production of vast amounts of information in a form that is neither convenient nor cost effective. This information is most often produced and distributed on paper and the resultant effort in production, distribution and retrieval is herculean. A possible solution to this, is the new optical laser technology and its use in the storage and retrieval of large amounts of information. Through the use of this technology in the non-classified areas of the Department of Defense the effort in all three areas can be greatly reduced and the end user can become more efficient. In many areas of DOD, the greatest benefit would be the regained space and weight associated with the distribution of the manuals and other typically paper products on a Compact Disc - Read Only Memory (CD-ROM). One CD-ROM weighs

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less than an ounce and is capable of storing over 270,000 pages of text. The saved shipping and handling costs alone would be astronomically reduced not to mention the end user who would have a more effective and efficient product. The CD-ROM is designed to work as a peripheral device to a microcomputer and can therefore be made available to any user with an IBM compatible microcomputer. The application/demonstration portion of this thesis took over 2 million database records, from the Transaction Ledger on Disc (TLOD), at the Naval Supply Center (NSC) in Oakland and pressed them to a single CD-ROM. The menu driven retrieval software with indexing on 3 criteria was also provided. It is evident that optical laser discs, principally in the form of CD-ROM, are more than just an innovative technology, indeed, they have an important part in the future of the U.S. Navy, of the Department of Defense, and all of our nation. The storage and retrieval of information is to be dramatically effected by this technology.

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Optical Laser Technology, Specifically CD-ROM, and Its Application to the Storage and Retrieval of Information

by

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Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1972

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

One of the significant problems of this "information age" is the production of vast amounts of information in a form that is neither convenient nor cost effective. This information is most often produced and distributed on paper and the resultant effort in production, distribution and retrieval is herculean. A possible solution to this, is the new optical laser technology and its use in the storage and retrieval of large amounts of information. Through the use of this technology in the non-classified areas of the Department of Defense the effort in all three areas can be greatly reduced and the end user can become more efficient. In many areas of DOD, the greatest benefit would be the regained space and weight associated with the distribution of the manuals and other typically paper products on a Compact Disc - Read Only Memory (CD-ROM). One CD-ROM weighs less than an ounce and is capable of storing over 270,000 pages of text. The saved shipping and handling costs alone would be astronomically reduced not to mention the end user who would have a more effective and efficient product. The CD-ROM is designed to work as a peripheral device to a microcomputer and can therefore be made available to any user with an IBM compatible microcomputer. The

application/demonstration portion of this thesis took over 2 million database records, from the Transaction Ledger On Disc (TLOD), at the Naval Supply Center (NSC) in Oakland and pressed them to a single CD-ROM. The menu driven retrieval software with indexing on 3 criteria was also provided. It is evident that optical laser discs, principally in the form of CD-ROM, are more than just an innovative technology, indeed, they have an important part in the future of the U.S. Navy, of the Department of Defense, and all of our nation. The storage and retrieval of information is to be dramatically effected by this technology.

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I. INTRODUCTION/BACKGROUND

A. GENERAL

The information age is upon us. It was reported that in 1985 the number of pages of printouts exceeded 2,000 for every man, woman, and child in America. [Ref. 1] What will we do, especially in the military, to meet this new era with the resources at hand? We cannot afford to be left behind, whether by technology or techniques. Some contemporaries have described it as an information explosion, and yet, an explosion is a singular, albeit powerful, event. The ground swell of this event is better described as a snowball rolled from the peak of the highest mountain. As it tumbles downward, it continues to increase it's momentum as it picks up more snow and velocity along it's path. From our vantage point, the slope is infinite, and although minor obstacles may be met along the way, it will continue on and on.

B. OBJECTIVE

The objective of this thesis is actually three-fold. First, the current technological capabilities in the area of optical laser research, as they apply to mass storage of information, will be addressed. Secondly, the suitability for such technology, especially in the military environment will be addressed. Finally, an application will be discussed followed by a description of a prototype implementation which serves as a demonstration of this technology.

The decision to use Compact Disc[1]-Read Only Memory (CD-ROM) for the application phase of the study was driven by a number of factors which all pointed to CD-ROM. Some of these factors were applicability, cost, time-frame, availability of proven hardware, and the presence of an established standard.

C. RESEARCH METHODOLOGY

The methodology involved in this research began with emersion in the literature (most of which resided in magazines and other periodicals) in an attempt to grasp the technology. Such a task is a very real attempt to separate fact from fantasy and genuinely available hardware from "vaporware". This endeavor was not without cost and a sponsor was sought. The purchase of a CD-ROM disc drive, associated hardware and software and the cost of the services to index and master the discs, were the major costs. Naval Supply Systems Command in Washington, D.C. identified a need, a prototype application and provided support funding for this project. The hardware was purchased and the complicated process of data formatting and transfer to disc was accomplished. The actual object of the resultant demonstration was a portion of an extremely large database consisting of over 3 gigabytes (gbytes) of information composed of over 12 million total records. The prototype application dealt with approximately 360 Mbytes and slightly more than 2 million records. Although a single CD-ROM can hold up to 540 MB, the total quantity of actual data held on a disc is often much less due to the indexing requirements. Sophisticated indexing schemes can even require more space than the data itself. An example of this is Grolier Electronic Encyclopedia which requires 60 MB to accommodate the actual text of the encyclopedia and 50 MB to accommodate the sophisticated index. (See Figure 1)

---

[1] There is wide disparity as to the spelling of the word,"disc", or "disk". It is customarily spelled with a "c" in the entertainment industry and with a "k" in the computer industry; with one important exception--the optical disc arena of computers where the "c" alternative is most commonly used. This "c" convention will be used throughout this thesis when referring to optical discs of any sort, and the "k" when referring to magnetic computer media.

The desired result of the research was to free up the two large Transaction Ledger On Disc (TLOD) disc packs each containing approximately 540 Mbytes of data and the associated mainframe computer and backup equipment. As an additional benefit the permanence and read only characteristics would also permit the elimination of the redundancy which now exists at all Naval Supply Centers. At times, during the data's life it resides in up to 5 places simultaneously: paper, 1/2" magnetic tape, microfiche, primary disk pack and backup disk pack (for the key files which simultaneously reside on 2 TANDEM 4104's).

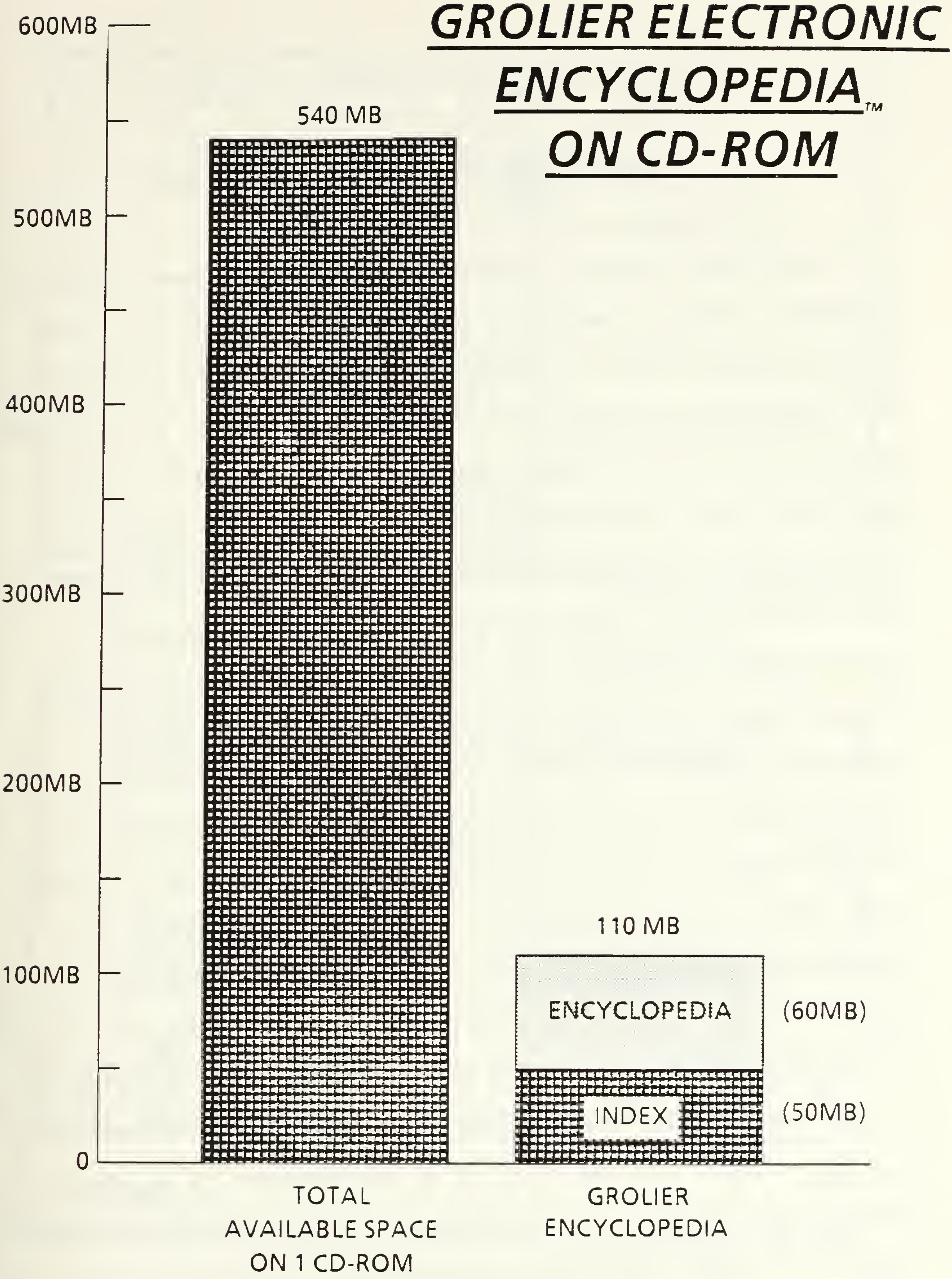
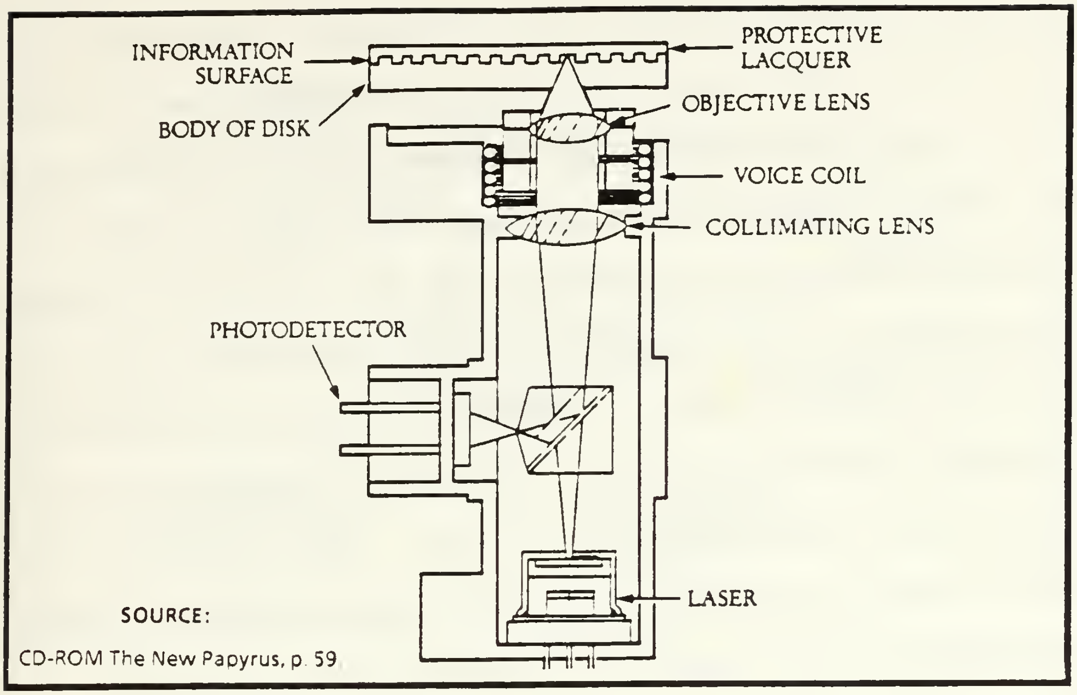


Figure 1. Grolier Electronic Encyclopedia On CD-ROM

II. CURRENT TECHNOLOGY/APPLICATIONS

What is it about optical systems that make them so special? Unlike magnetic products, the optical laser system stores data as submicroscopic pits or spots in the reflective surface of a disc. In order to read the disc, a low-power laser, shining a pinpoint of light less than one millionth of an inch wide, bounces off the pattern of shiny and dull patches which is, in turn, converted into a digital signal of ones and zeros, and read by an optical head of an optical disc drive. (See Figure 2) Presently there are three distinct categories of optical-recording products: prerecorded, write-once and erasable. (See Figure 3) Of the three, only the prerecorded and the write-once have truly entered the public domain. Optical-recording is accomplished by means of a higher-power laser, which forms small pits in the reflective surface of an optical disc. A pit is a microscopic depression in the reflective surface of a CD-ROM. A typical pit is approximately the size of a bacterium: 0.5 by 2.0 microns (millionths of a meter). A pit represents data from 2 to many bits depending on the length, or run, of the pit. The raised and reflective surface between 2



SOURCE:
CD-ROM The New Papyrus, p. 59

Figure 2. Optical Head Of A CD-ROM Drive

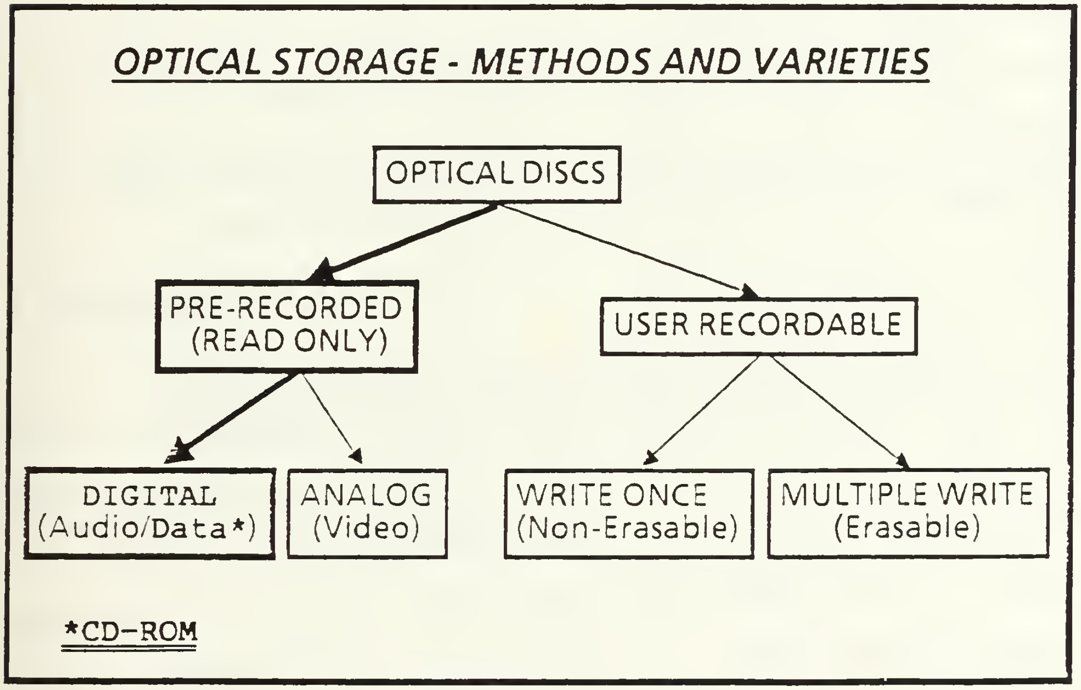
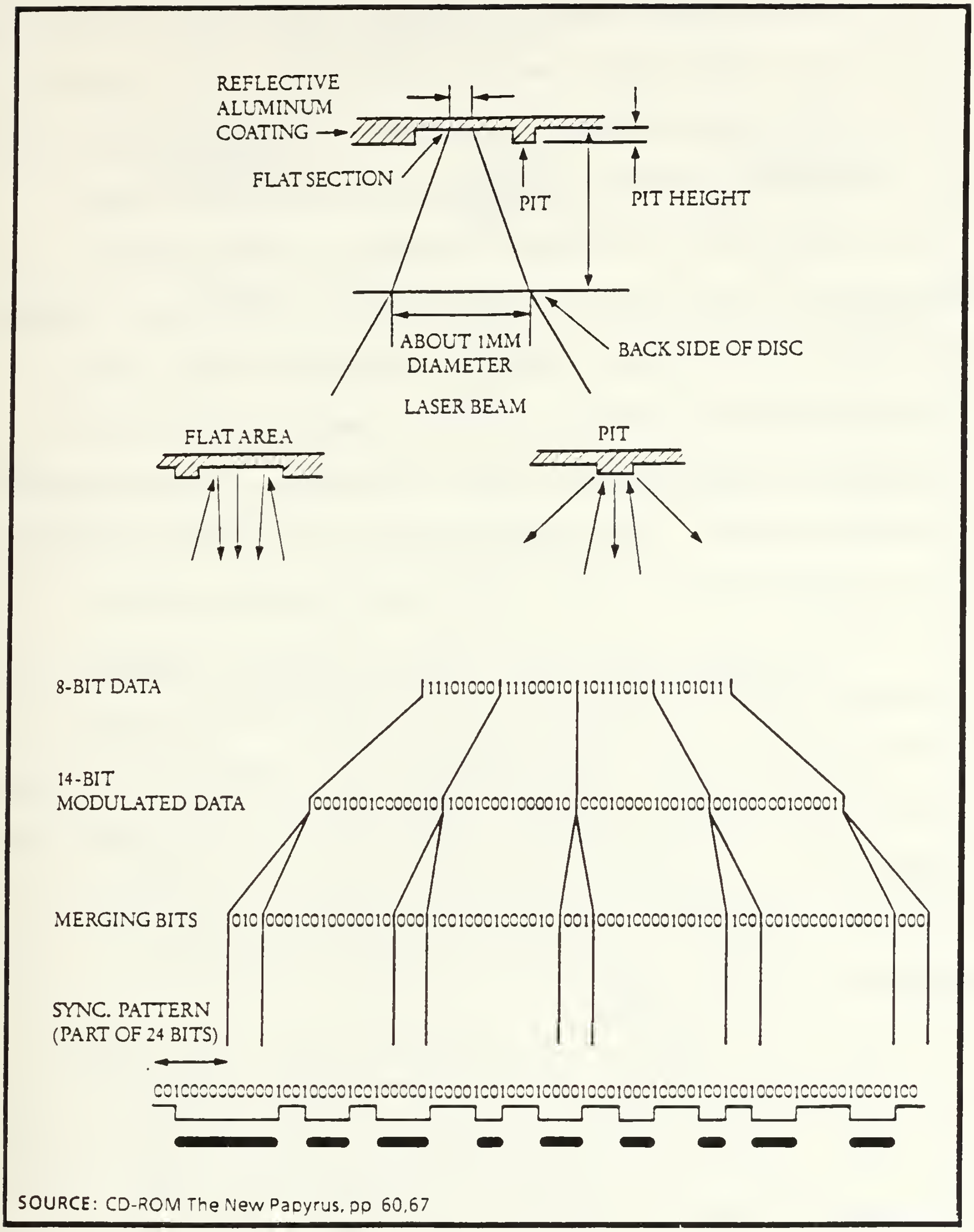


Figure 3. Optical Storage--Methods And Varieties

adjacent nonreflective pits is called a land and can also vary in its representation of data from 2 to many bits. In CD-ROM coding, a binary one is represented by the transition from pit to land and land to pit, and 2 or more zeros are represented by the distance between transitions. (See Figure 4) The resultant series lands and grooves are ultimately interpreted as one's and zero's and thus a wide variety of digitally encoded information can be stored on disc. When "reading" an optical disc, a low-power laser, senses, the presence or absence of the lands and grooves by means of reflected light energy. The small laser beam used to read back data is reflected from the lands, and scattered by the pits.

Of the prerecorded discs, the CD-ROM is the most common and draws heavily on it's predecessor, the CD-Audio Disc, for format, wide acceptance and manufacturing facilities. The recording format is a spiral groove approximately 3 miles long with a capacity of 540 MB. The tracking is maintained via the constant linear velocity (CLV) technique which requires variation of the disc rotation speed based on the distance of the read head form the center of the disc. The prerecorded disc is 4.72 inches in diameter and it's uses are primarily in the area of database distribution and permanent archival of vast amounts of



SOURCE: CD-ROM The New Papyrus, pp 60,67

Figure 4. The Conversion From Pits To Bytes

records. The other type of prerecorded optical disc is the Optical Read Only Memory (OROM) which is slightly larger than the CD-ROM. The OROM discs are generally 5.24 inches in diameter and may be formatted with either concentric or spiral tracks. Although the capacity of the discs is very similar, OROM is often operated in a constant angular velocity (CAV) mode, thus allowing for faster access times. The typical 5 1/4" floppy disc used the CAV technique. Also, OROM may be two sided. The predominance of the CD-ROM is most probably due to its similarity to the large CD-Audio market, and the fact that CD-ROM is the only form of optical-recording that, as of this writing, has an established standard. The OROM is not expected to make a significant impact in the near future and indeed may be subsumed by the more dominant forms of optical-recording. OROM will therefore not be further addressed in this paper.

Of the two types of recordable discs, the WORM generally uses the CAV technique and the erasable disc technology is currently experimenting with both techniques without a clear winner yet identified. Some of the varying physical characteristics can be seen in the following table.

TABLE 1. PHYSICAL CHARACTERISTICS COMPARISON OF OPTICAL MEDIA

	CD-ROM	WORM DRAW OD^3	ERASABLE
SIZE:	4.72	3.5" 5.25" 8" 12" 14"	UNKNOWN
CLV/CAV:	CLV	CAV (predominant)	UNKNOWN
SIDED:	ONE	CAN BE TWO	CAN BE TWO

A. CD-ROM (COMPACT DISC - READ ONLY MEMORY)

Some call it "the marriage of the century", and we watch the union of optical storage devices with microcomputers. CD-ROM is the partner in this marriage that promises an effective means of preserving material and information needed for archival, immense storage capacity, and the easy and relatively fast access and retrieval of that material. This, combined with the demonstrated power of today's microcomputer and its capabilities allows the retrieval to be accomplished through an often extremely sophisticated series of statements and Boolean options. Once retrieved, the manipulation of the data and the rapid transfer to other mediums is a simple task.

The first real application aimed at the average consumer was the Grolier Encyclopedia which was produced in 1985 and sold with the CD-ROM reader for $995. The encyclopedia is therefore pure textual information and contains no graphics. The actual textual information comprises approximately 60 Mbytes of storage space on the disc while the indexing and file schemes for retrieval use approximately 50 Mbytes of data, leaving over 430 Mbytes of space on the disc. [Ref. 2] (See Figure 1) One of the unique cost savings opportunities is the mastering of such discs in conjunction with another company and their application and simply restricting access by a password mastered as part of the specific application or contained on the 5 1/4" floppy disk used as file access software with the CD-ROM.

The future key to user appreciation and purchase of software is anticipated to be graphics applications that can now be mastered to CD-ROMs as well as text. Generally, text is stored in ASCII format, while graphics bit-mapped or raster scanned for storage as digital information. Some graphics also use the vector logic technique. In addition, many companies have implemented highly sophisticated compression algorithms which greatly increase storage capability. Beyond the integration of text and graphics is Compact Disc

Interactive (CDI) where the resulting mixture of text, color graphics, animation, and audio can be achieved. This technology is in the formative stages, however it is certainly one that will appeal to many applications, especially education and training. With current compression techniques, up to 2 hours of true color video has been placed on a CD-ROM.

"DeLorme Mapping Systems of Freeport, Maine has stored DeLorme's World Atlas on a Sony compact-disk laser drive. The Compaq Deskpro 386 displays maps of the entire Earth from one laser disk attached to a PC. The application also runs on 80286-based MS-DOS computers." [Ref. 3]

B. WORM (WRITE ONCE READ MANY)

Optical laser technology, today, has also branched into the write once technology. Discs in this area come in a variety of sizes and an even broader variety of formats. Various formats due to the lack of standards have caused this market, or application, to falter in all but a few specific areas. The systems are usually sold as an entire package and are often not capable of being integrated with current hardware. The discs, most often, are 5 1/4 inch and are contained in a plastic case with a slide window. The disc drives come either as separate units or as built-in drives

TABLE 2. SUMMARY OF CD-ROM CAPACITY EQUIVALENTS

A SINGLE CD-ROM CAN HOLD THE SAME INFORMATION HELD BY:

- *270,000 PAGES OF TEXT OR,*
- *20,000 PAGES OF IMAGES SCANNED AT 300 x300 DPI OR,*
- *10,000 PAGES COMPRISED OF 1/2 TEXT AND 1/2 GRAPHICS OR,*
- *1,500 5 1/4" FLOPPY DISKS OR,*
- *1,200 MICROFICHE CARDS OR,*
- *1,104 HOURS (46 DAYS) OF DATA TRANSMISSION AT 1200 BAUD OR,*
- *27 20-MB WINCHESTER DISKS OR,*
- *10 STANDARD 1/2 ", 9-TRACK TAPES OR,*
- *1 HOUR OF FULL MOTION, FULL SCREEN, FULL COLOR VIDEO.*

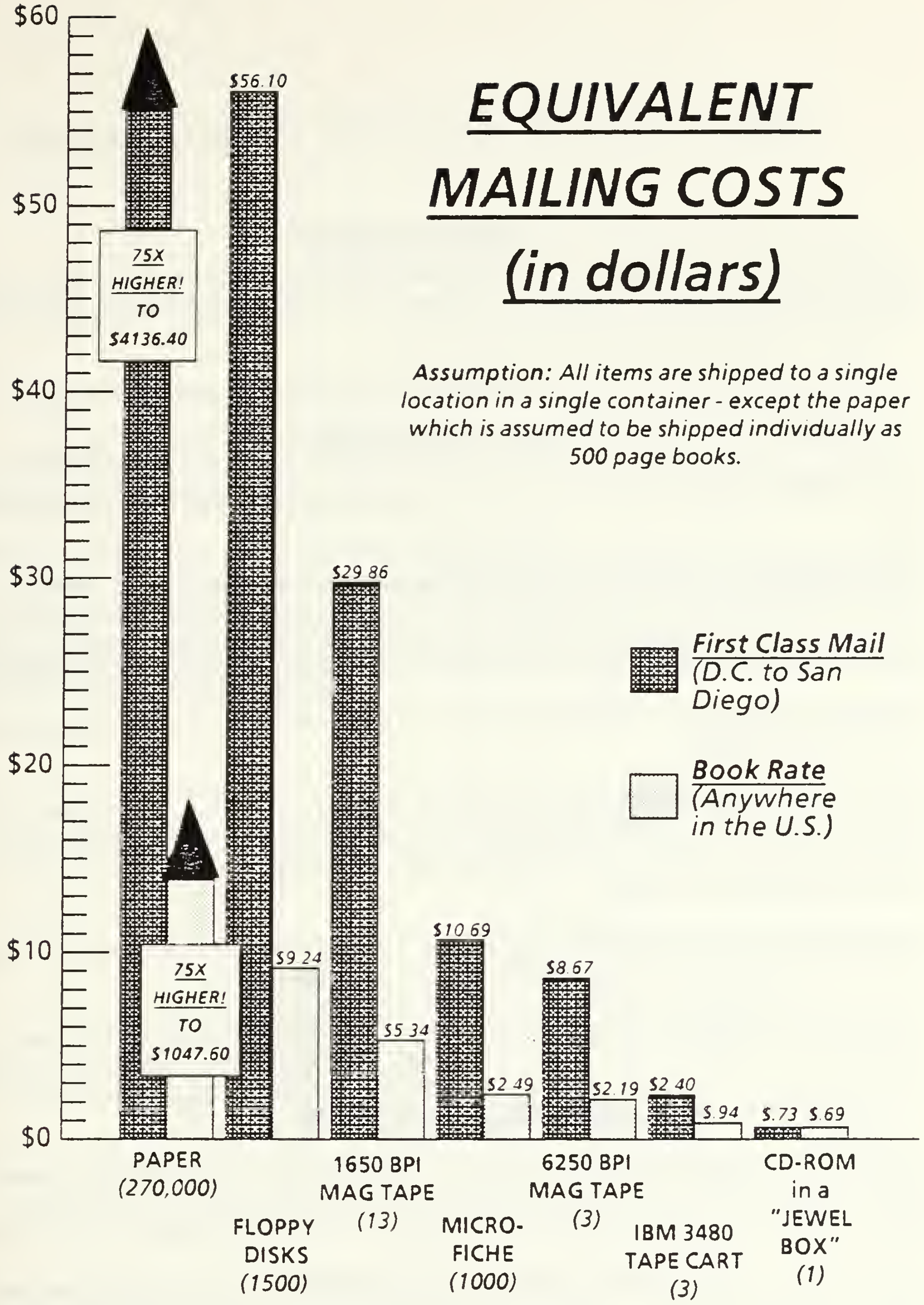


Figure 5. Relative Mailing Costs For 540 MB Of Information

TABLE 3. CD-ROM ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- **PERMANENT/DURABLE**: It is an excellent archival medium (currently Sony disks are guaranteed for 50 years.) Also very rugged and able to withstand adverse weather and handling conditions.

- **NON-VOLITATILE**: No loss of altering of data during power failure or surges.

- **LOW COST**: The 'per MB' cost of data is less than any storage medium.

- **EXTREMELY PORTABLE**: The media is removeable and offers portability of data.

- **SECURITY**: Physical control can be maintained easily and thus large quantities of sensitive data can be controlled. Also, the possiblity exists to manufacture the disk out of glass instead of polycarbonate material and thus, for military purposes emergency destruction could be easily accomplished.

- **SMALL PHYSICAL VOLUME/WEIGHT**: Easily carried, or mailed etc, at a very reasonable expense.

- **NOT ABLE TO BE ALTERED**: This media is Read Only Memory (ROM) and as such, it is extremely useful for audit trails in the legal and financial world where magnetic media have not been allowed as evidence due to the alterability of that media.

- **ENORMOUS DATA STORAGE CAPABILITY**: Up to 600 MB of data on a single side of a single disk which is only 4.72 inches in diameter.

- **USER FAMILIARITY**: It is simply another PC peripheral that, to the user, looks just like a read only MS-DOS etc. disk. Also, the average user has had experience with the same physical disk in the CD-Audio environment and therefore feels more comfortable with it all ready.

- **BACKUP IS ELIMINATED**: There is no need to backup the disk because it is ROM. For safety sake, mulitiply copies can be ordered at the time of disk pressing and stored in separate locations.

- **ELECTRO-MAGNETIC PULSE (EMP) HAS NO EFFECT**: This is not a magnetic media and therefore any sort of electro-magnetic energy has no effect on it.

- **NO HEAD-CRASHES**: The read-device is optical and does not contact the disk in any way, therefore, head-crashes are virtually eliminated.

TABLE 3. (Continued)

DISADVANTAGES

- **READ ONLY**: This feature, while a benefit to some is a hindrance to others desiring to alter their data.

- **INITIAL COSTS FOR ADDITIONAL HARDWARE**: Although this is true of any new system, it is viewed by many as a disadvantage when compared against the all ready sunk costs of the presently installed system.

- **SLOW ACCESS SPEEDS**: The average time to retrieve data, when compared to hard disk etc. is much longer.

TABLE 4. COMPARATIVE ACCESS SPEEDS

	Floppy Disk	Hard Disk	CD-ROM
Storage Capacity:	360KB-1.2MB	10MB - 70MB	540MB
Revolving Speed:	300 RPM	3,000 RPM	200-500RPM
Access Time:	100 msec	28-70 msec	0.4-1 SEC.

Note: Backup of 10M of data from hard disk onto floppy disks can take up to 1 hour.

TABLE 5. CD-ROM CHARACTERISTICS SUMMARY

PHYSICAL

Size:	Diameter:	4.72 inches (120mm)
	Thickness:	1.2mm
	Center Hole Diameter:	15mm
	Weight:	0.902
	Layers:	Polycarbonate (plastic) base overlaid with a thin reflective metal coating topped with a protective layer of polycarbonate.

RECORDING

Track Characteristics:	CLV
Speed of:	500 RPM on inside tracks to 200 RPM on outside tracks
Length of Recording Track:	3 miles long, starting from the center of the disc and working out
Density of Information:	2.84 KB/linear tracking inch
Track Density:	16,000 tracks per inch (tpi) (for comparison, a floppy disk has a tpi of 96)
Total Information Storage:	540 Mbytes
Spacing Between Tracks:	1.6 microns
Size of Single Pit:	0.4 to 0.6 by 2 microns and 0.12 microns deep

TABLE 5. (Continued)

Read Only:	One sided (reads only the bottom of the disc, and the top simply contains the label and is not used for recording purposes)
Read Medium:	Gallium arsenide
Laser Read Power:	Laser using near infrared light focused to 1/25,000 inch (1 micron)
Read Rate:	150 KB/second
Access Time:	0.4 - 1.0 seconds
Rotational Latency:	60 - 130 milliseconds
Read Head Separation:	Approximately 1/25 inches (for comparison, this is 2,000 times greater than the distance between a Winchester head and associated magnetic disk.)
STD:	Yes--High Sierra
ECC:	Continuous-Interleaved Reed-Solomon Code (CIRC)

fitting into one of the standard floppy drive slots on an IBM or compatible computer. The discs are most often known as Write Once Read Many (WORM), but are also know as Direct Read After Write (DRAW) which is a variation on the WORM, giving it the capability to verify the data by reading it immediately after writing to the disc. The discs are generally two sided and can contain approximately 200 Mbytes of data per side. The discs operate at a constant angular velocity (CAV) and the blanks cost approximately $100 each. The discs are preformatted so, unlike magnetic media, there is no formatting or initialization process that is required prior to writing to the disc. This is because the discs are manufactured with a track or groove to facilitate recording.

The acceptability of this technology is limited because no standard presently exists. Every set of hardware and software is a separate entity with little hope for compatibility now, or in the near future. This has precluded its wide acceptance and has also added to the diversity of even the physical format and size. These write once discs can be found in several sizes, including 3.5 inch, 4.72 inch, 5 1/4 inch, 8 inch, 12 inch, and 14 inch.

The future of the write once technology appears to be limited, especially with erasable technology becoming a viable technology in the near future. Much of the demand for write once will be redirected to the more effective and reuseable erasable media when it becomes available. Write once technology may continue to serve fields of law, accounting and other areas where an audit trail is mandatory. Magnetic media has not suited this purpose well, and has not been accepted as evidence in the courts of law because of the ability to change the data without any trace of having altered the information. Another WORM application that has been effectively used is as an intermediary step to the production of a CD-ROM. The information is obtained and put on a very high capacity hard disk system (capacity at least as large as one side of a write once disc--approximately 200 Mbytes) to accommodate the indexing and data preparation that is necessary to effectively place the information on a CD-ROM. The indexing and data preparation put the data in a format with the appropriate indexes to facilitate rapid retrieval. The information is then written to the WORM and then sent to a company for actual mastering. Presently, there are few companies in the United States capable of the process.

The write once ability is very limiting for data that is dynamic, and large. For example, if one has a database containing 50 Mbytes of information, then it can be written to the WORM using 25% of one side of the disc. If a change is necessary to that same data, it must be read into the computer, the change applied and the entire database written to the WORM again. The resultant disc usage would then be 50% of one side of the disc. The actual amount of data changed could be as small as one byte. Updating 8 times would fill the entire disc (both sides). In addition, although writing data to disc is convenient, unless one has access to a powerful retrieval engine, the data may take ages to search because it is not organized and indexed in an optimum search format/structure.

This problem increases geometrically when you consider a 12 inch disc using the CLV format containing over 27 miles of track (on a 12 inch disc)--that's a lot of searching revolutions at any rpm!

C. ERASABLE DISCS

The erasable disc and its associated technology is not yet mature and simply exists as vaporware, or research and development equipment, in the labs of many hopeful companies. When the technology reaches maturity as well as the consumer market, it will have a profound impact on the WORM market. However, the CD-ROM market will remain relatively stable due to its unique applications and characteristics. Its read only nature and its small and lightweight characteristics make it an excellent media for the distribution of large quantities of information. The microcomputer peripheral equipment environment is familiar and reasonably-priced. As with the WORM technology, there is no logical or physical standard as yet for the erasable technology and as such many end users are extremely wary of investing in something that could become obsolete overnight. The early establishment of the physical standard for a CD-ROM is a major factor in its acceptance and the 'piggyback' effect that it has experienced from the huge market of CD-Audio.

Today there are three main types of erasable optical media being developed: Magneto-Optic (MO) (occasionally referred to as Thermo-Magneto-Optic (TMO)), Phase Change (PC) and Dye/Polymer (DP).

1. Magneto-Optic

The Magneto-Optic (MO) recording system stores information in the disc in the form of vertically oriented magnetic domains. Of the three types of erasable technology, the magneto-optic is the most mature. Like most other optical drives, recording is a thermal process. In this case, an intense laser beam heats a small region of the magneto-optical active layer in the presence of a magnetic field. The heating decreases the coercivity of the active layer so that the external magnetic field can reorient the field of the heated region. Upon cooling, a stable magnetic domain is formed, with no mechanical or chemical change. The recorded domains are read back by a low powered scanning laser beam and an optical system capable of sensing small changes in the polarization of the scanning beam caused by the magnetic domains. This media has no true overwrite capability and, therefore, it must complete an erase cycle before a write cycle is possible. There is some possibility that a disc could be erased as a whole, by subjecting it to a large magnetic field while it was heated. One of the main benefits of the optical laser technology is that it is unaffected by magnetic fields of any size, or of Electro-Magnetic Pulses (EMP). This benefit is lost in any erasable media that involves magnetic fields and therefore, certain applications may be forced to remain in the CD-ROM and WORM technology which is purely optical and remains unaffected by any magnetic interference.

2. Phase Change

The Phase Change (PC) media works on the basis of detecting a phase change in the medium. Because of the chemical nature of the material being tested today, this technology suffers some read cycle degradation and Media life is currently about three years. As a result this media is not expected to be accepted by industry or users as long as superior products exist in the marketplace. [Ref. 4].

3. Dye/Polymers

The Dye/Polymers (DP) look promising and are the newest and most exciting of the erasable technologies. Initial results of early testing indicate high performance and overwrite capability. The availability of this media and its read cycle degradation are still under study. [Ref. 4]

D. FUTURE TECHNOLOGIES

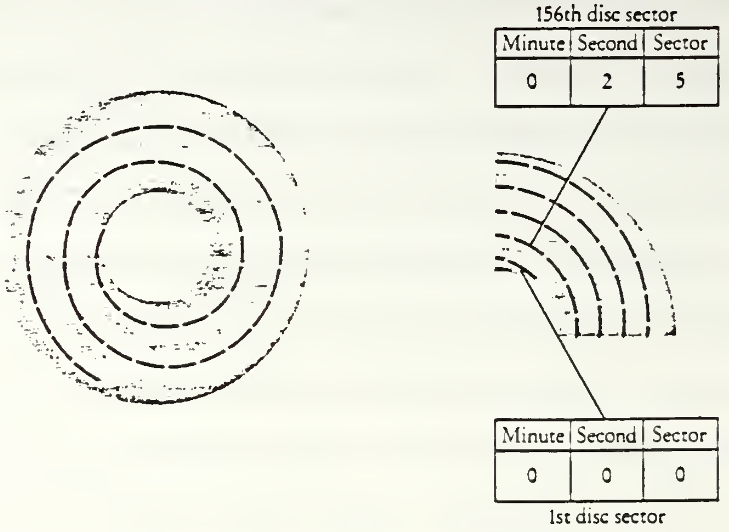
Where do we go from here? It was only a decade ago that Philips invented the compact audio disc and only two years ago that it truly became a product of wide consumer use.

The 'ultimate' future seems to be the erasable optical disc, although none of the dozen electronic companies experimenting with them has perfected the technique as yet. [Ref. 5] The technology is capable of supporting such a medium today, however only in a controlled and cumbersome environment. It is a giant step from the prima donna world of the prototypes to the marketplace of the user. The current erasable discs are either too costly for most audio applications, or too insensitive for most video and data recording. [Ref. 4] Certainly the quest for such a medium--with all the benefits of huge amounts of data storage, combined with erasability, is being pursued by numerous companies. When addressing the future and the erasable compact disc, one of the leading companies is 3M who "Next year plans to begin supplying limited quantities of erasable computer disks". [Ref. 5]

Future use of optical laser disc, even with the comparatively large amount of data storage there are applications where even that high limit is too restrictive. In such cases the difficulty can be overcome by use of a device which can store as many as 1.2 terabytes of data. This device is very similar to the familiar jukeboxes in the cafes of years ago. It is capable of storing multiple CD-ROM's and accessing them quickly by mechanical means. Once retrieved either a single, or multiple, disc drive(s) read the data. These devices are called optical jukeboxes.

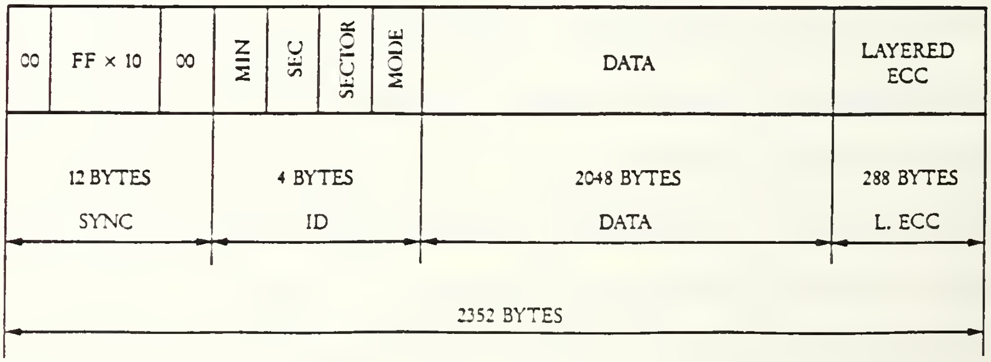
Another option is Reference Technology's CLASIX MultiDrive Director Series 500 which can simultaneously access with CD-ROM's in eight disc drives all connected to a single microcomputer. This system can access up to 4.32 gigabytes of stored data.

Currently CD-ROM is the only non-audio optical laser technology that has an established physical standard. The standard ensures that the physical format of a disc is standardized, which means that all CD-ROM drive manufacturers agree on what a sector is and how to address it. An example of this would be a specific piece of information located on the disc at minute 47, second 13, sector 4 (47:13:4). (See Figures 6 and 7) With this information, one could read the data and at this physical level all discs are interchangeable from one drive to another. "Figures such as 500, 550, 552, 553, and 600 MB appearing in the literature describing the capacity of a CD-ROM disc reflect only different decisions about how much of the disc to use, as no variations of track pitch, block structure, ECC, or any other attribute of CD-ROM are permitted within the standard." [Ref. 6] The logical format however, does not currently have an established standard, although a defacto standard is recognized, and one can not therefore guarantee the interchangeability of discs. Even with only the physical format agreed upon, the users are able to press ahead into areas previously too unfamiliar and unstable to be economically sound. Prior to the acceptance of a standard, a CD-ROM mastered by one company could not be expected to work with the hardware or software of another vendor. With careful system specification to ensure the vendor uses the established standards, even the defacto ones, the user can



SOURCE: CD-ROM Optical Publishing, p. 36

Figure 6. CLV Addressing Scheme



SOURCE: CD-ROM The New Papyrus, pp 68

Figure 7. One CD-ROM Block

reasonably expect to purchase a single CD-ROM disc drive that will be able to read numerous discs from a wide variety of sources, or the inverse, where any disc can be read on any disc drive. Also, production of a generic variety of retrieval software is now possible for the first time in the optical laser disc arena. This capability has nearly been achieved today through the use of Microsoft's MS-DOS extensions which treat the optical disc drive as a very large read-only hard disk.

At the Office Automation Conference in the fall of 1986, "Distributed Image Systems Corporation of Northridge, California, exhibited a laser disk-based storage and retrieval system that uses an oversized jukebox to store and retrieve the write-once optical disks. The jukebox can hold 1,600 gigabytes of data, with methods to allow multiuser access in seconds...." [Ref. 7]

III. OPTICAL LASER TECHNOLOGY VS PAPER--A BRIEF COST/BENEFIT COMPARISON

One of the key factors in choosing CD-ROM as the media for data is its ability to reduce costs associated with information storage and retrieval. Another reason for the selection of CD-ROM is its extremely reliable error correction accomplished by means of the Error Detection Code (EDC) and the Error Correction Code (ECC). Error detection codes used in CD-ROM have non-detection probabilities below 10^{-25}. This means that one could expect a single undetected wrong bit in 2 quadrillion CD-ROM discs.

The nature of the information, and the frequency of the required update must be clearly evaluated in each case to ensure that the medium is appropriate for the task. Certainly the capabilities of CD-ROM or other optical laser media are impressive, and yet, they are not necessarily the panacea for today's plethora of information distribution.

Today's information distribution focuses on the use of paper, micrographics, microfiche, aperture cards, or telecommunications--all of which are expensive compared to the surprisingly low costs of doing the same job with CD-ROM. The density is significant when one considers CD-ROM's ability to find the proverbial 'needle in a haystack' almost instantaneously. Given an average page of textual information, a single CD-ROM weighing approximately one ounce can hold over 540 megabytes of information, the equivalent of 270,000 paper pages whose total weight could constitute 1.42 tons! See Figure 8 for the weight of various storage media capable of storing 540 MB of data. These statistics get even more staggering when you consider that one personal computer with a stack of 8 networked CD-ROM drives can access up to 2 million text pages (over 4 billion bytes of information) of data, constituting a potential weight in paper of 22,680 pounds (11.34 tons!).

Herein may lie the most significant benefit for the Department of Defense community--space and weight. This story can be retold a thousand ways and for a thousand applications, and yet the solution is beginning to become obvious: CD-ROM can store vast quantities of information with significantly reduced space and weight requirements. An example would be the weight of documentation associated with the F-16 aircraft. (see Figure 9) Another example would be the large volume of paper involved with the production and distribution of the Naval Ships' Technical Manuals

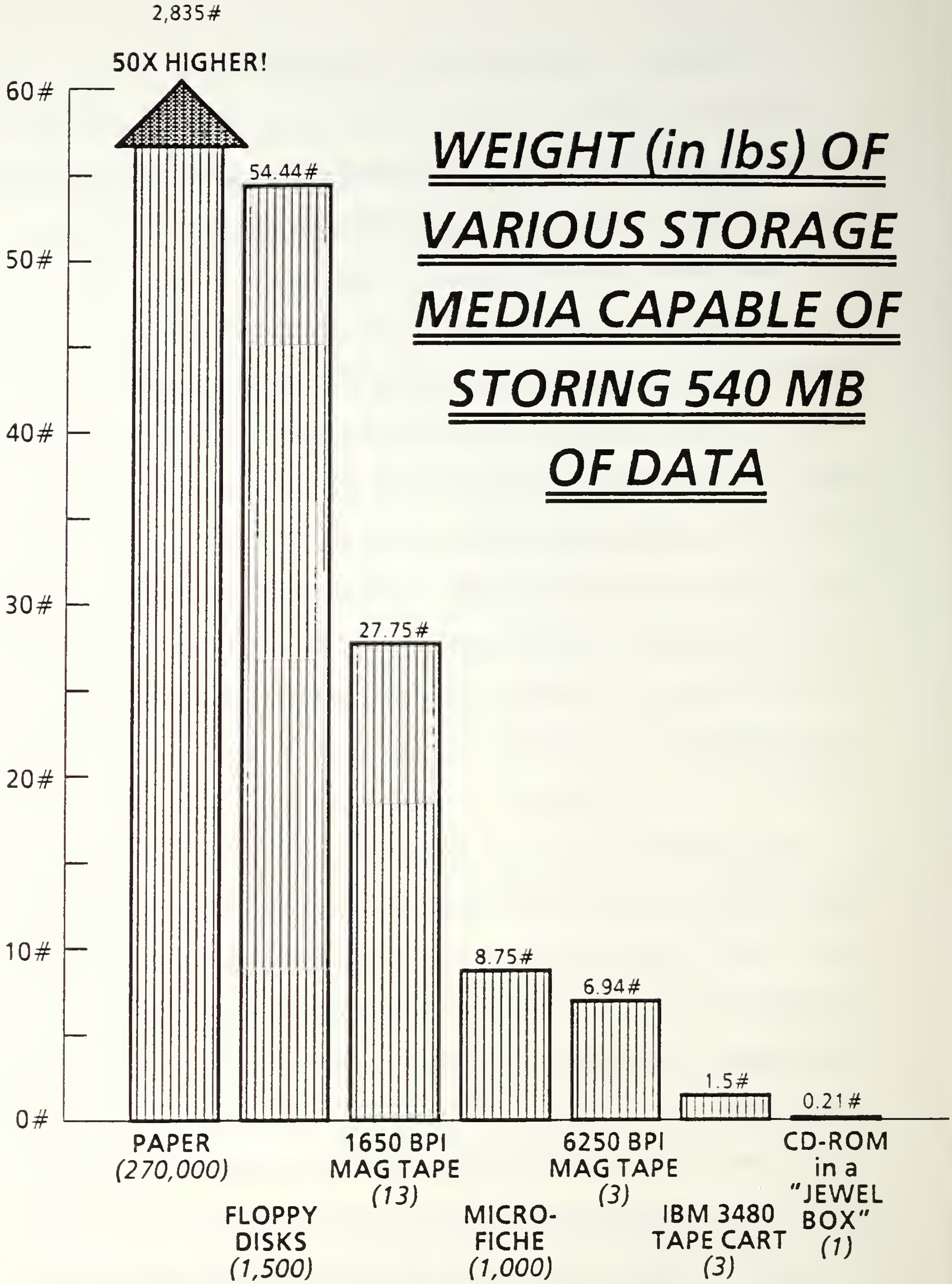
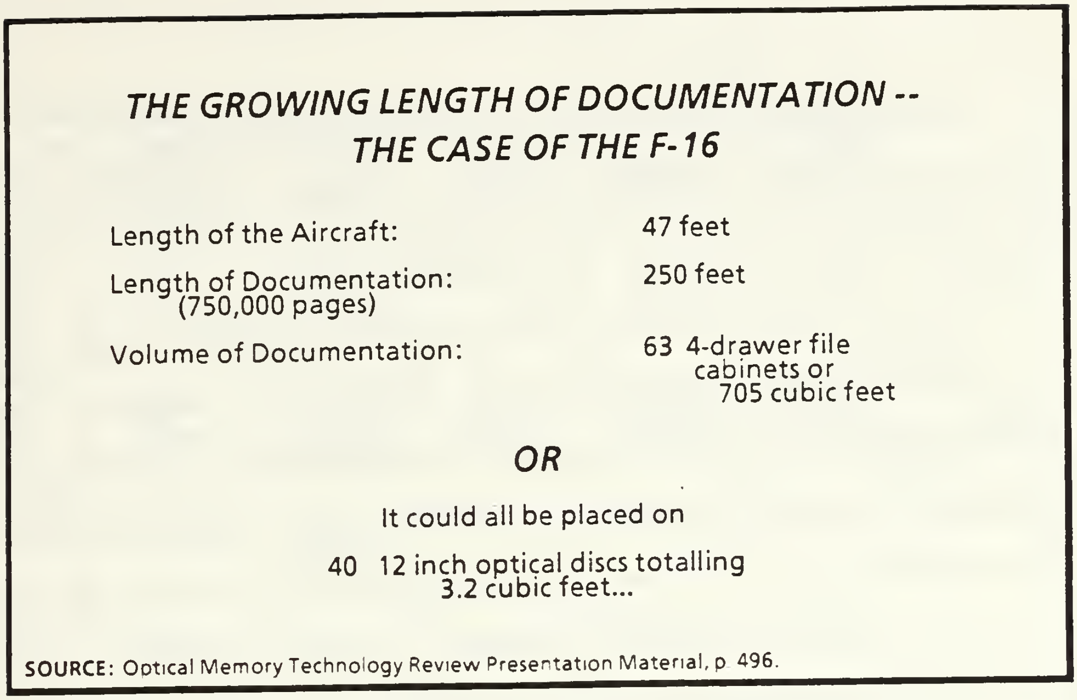


Figure 8. Weight (in lbs) Of Various Storage Media Capable Of Storing 540 MB Of Data



THE GROWING LENGTH OF DOCUMENTATION -- THE CASE OF THE F-16

Length of the Aircraft:	47 feet
Length of Documentation: (750,000 pages)	250 feet
Volume of Documentation:	63 4-drawer file cabinets or 705 cubic feet

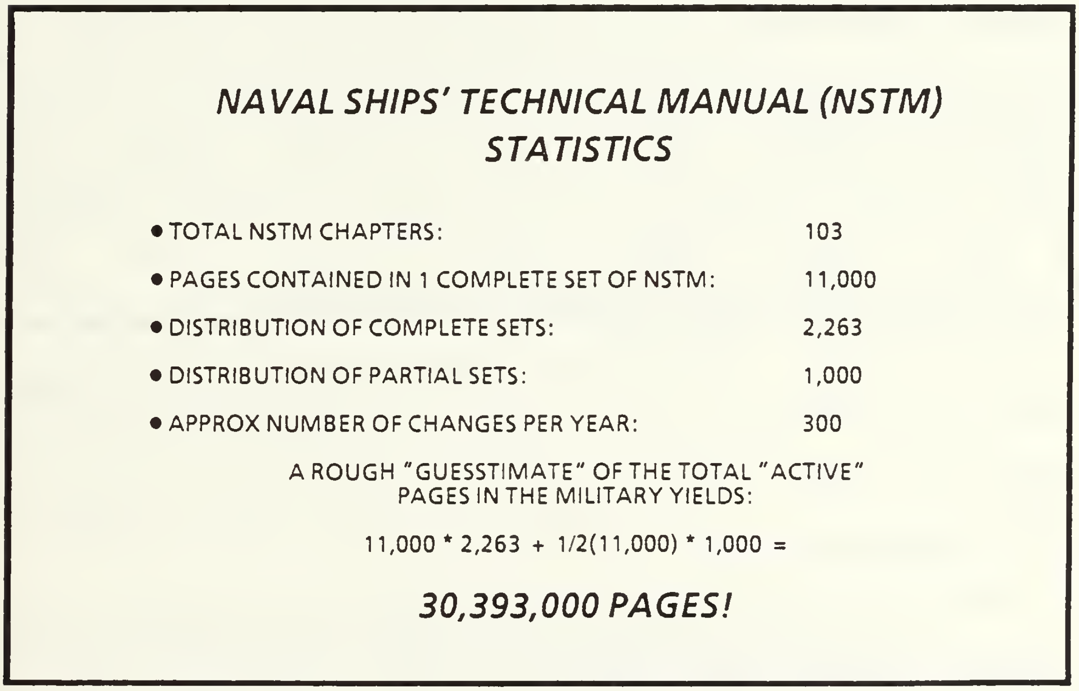
OR

It could all be placed on

40 12 inch optical discs totalling 3.2 cubic feet...

SOURCE: Optical Memory Technology Review Presentation Material, p. 496.

Figure 9. The Growing Length Of Documentation-- The Case Of The F-16



NAVAL SHIPS' TECHNICAL MANUAL (NSTM) STATISTICS

• TOTAL NSTM CHAPTERS:	103
• PAGES CONTAINED IN 1 COMPLETE SET OF NSTM:	11,000
• DISTRIBUTION OF COMPLETE SETS:	2,263
• DISTRIBUTION OF PARTIAL SETS:	1,000
• APPROX NUMBER OF CHANGES PER YEAR:	300

A ROUGH "GUESSTIMATE" OF THE TOTAL "ACTIVE" PAGES IN THE MILITARY YIELDS:

$$11{,}000 * 2{,}263 + 1/2(11{,}000) * 1{,}000 =$$

30,393,000 PAGES!

Figure 10. Naval Ships' Technical Manual (NSTM) Statistics

which are used by nearly every command in the U.S. Navy. (See Figure 10)

In addition to space and weight savings, the relative costs per Mbyte of data are respectively lower in nearly all cases. (See Figure 11)

The optical laser disc in the CD-ROM format could be immediately introduced in nearly all areas of the Department of Defense with the addition of minimal hardware. In the case of a text-only application, the CD-ROM disc drive would be sufficient. This ease of introduction is primarily due to the extensive use of IBM PC's or compatibles presently in use by the government. With the commencement of the 1986-87 academic school year, all three service academies issued IBM compatibles (Zenith Z-248's) to each member of the incoming class. it is estimated that by the year 1990 there will be over 500,000 microcomputers in use in the government. [Ref. 8]

Disc drives are currently available for as little as $600 each, either as a stand-alone units or as internal drives that fit into one of the 5 1/4" drive slots in a PC. There are even a few half-height models now available also.

The opportunities of the technology are quickly being experimented with and often realized. "Federal agencies are leading the way in the innovative use of

MEDIA	Small Winchest. Disk	Large Optical ROM	Floppy Disk	Magnetic Tape	Large Winchest. Disk	CD-ROM
Media Cost ($)	N/A	15-30	1-5	10-20	N/A	10-20
Drive Cost ($)	500-3,000	7,000-100,000	200-1,500	3,000-15,000	10,000-150,000	500-2,500
Capacity (in MB)	5-50	1,000-4,000	0.36-1.20	30-300	50-4,000	540-680
Cost per MB ($)	63.63	21.41	1093.59	54.64	39.51	2.48
Media Size (in.)	5.25	12.00	5.25	10.50	14.00	4.72
Access Time (sec)	0.03-0.30	0.03-0.40	0.03-0.05	1-40	0.01-0.08	0.40-1.0
Density (bits/in.)	15,000	35,000	10,000	6,250	15,000	35,000
Data Rate (KB/sec)	625	300	31	500	2,500	150

SOURCE: CD-ROM Optical Publishing, p 37

Figure 11. Media Comparison Chart (including Cost Per MB)

optical storage techniques, according to William J. Hooton, Director of Optical Digital Storage Systems for the National Archives and Records Administration. " 'Interest (in optical systems) in the federal market is very, very, high. Most agencies have some type of project,' Hooton said." [Ref. 9]

The IRS has begun a project called Files Archival Image Storage and Retrieval which it estimates will result in annual storage costs savings of as much as $36 million annually. [Ref. 10]

IV. PRODUCTION STAGES (DESIGN TO DELIVERY--THE GENERIC PATH)

Due to the relatively recent introduction of computers, and especially microcomputers, into the Department of Defense, the majority of the information currently resides in some form of hard copy such as paper or microfiche, while only a small percentage resides in digital form. This trend is rapidly changing and projections reflect a reversal in a very short time span. In a letter from the Chief of Naval Operations a directive for digitizing nearly all current and future records was established and the goal of the first "paperless" ship in 1990 was established. [Ref. 11]

Nearly any form of information or image can be digitized, thus accomplishing the first stage toward creating an optical laser disc.

A. CONVERSION

An often asked question is, "If the data is not in digital format, is it worthwhile to convert text, fiche, et cetera to digital information in order to be mastered to optical laser disc?" The answer, of course, differs in each case and while some may convert all archival files to optical disc, others may commence the new procedure as of a specific date or event, while others may not convert at all.

The Optical Character Reader (OCR) process as developed by Optiram Ltd., a firm based on the island of Jersey between England and France, is so sensitive and intelligent that it is capable of converting almost any kind of type size, font, or even handwriting which can be quickly scanned into a computer-readable ASCII file. [Ref. 9]

The overall CD-ROM life cycle begins with the data and continues through customer support, as depicted in Figure 12.

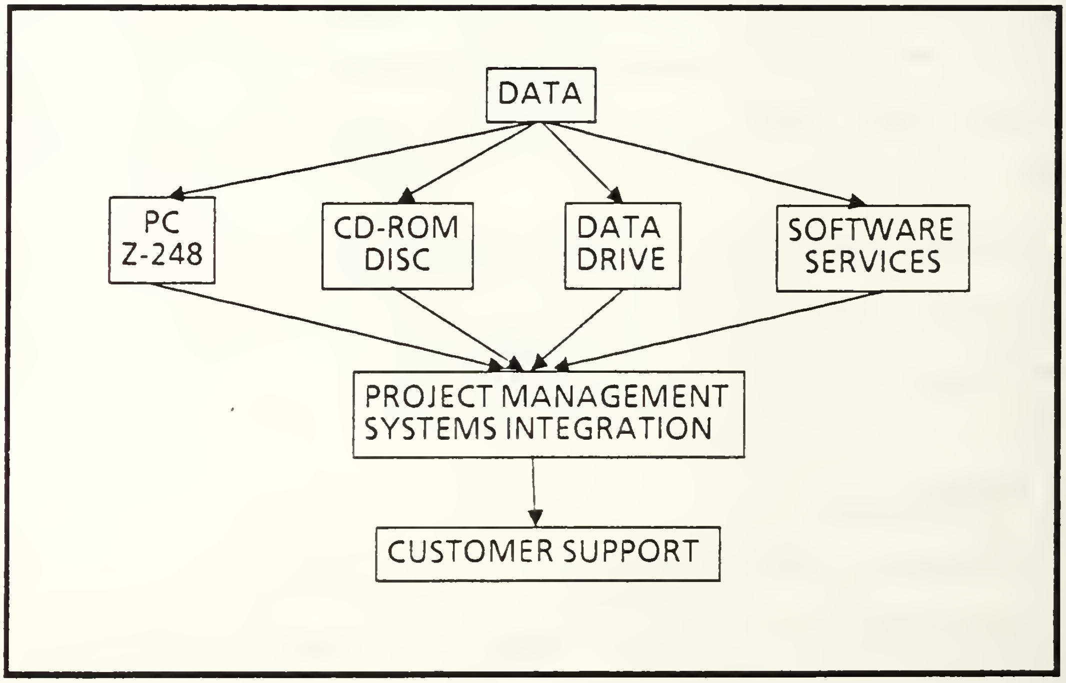


Figure 12. CD-ROM Life Cycle

B. STEPS IN DEVELOPING A CD-ROM PRODUCT

There are eight basic steps in the process of developing a CD-ROM product and the following paragraphs summarize each of these steps. (See Figure 13)

1. User Requirement Definition

The first step is not unique to a CD-ROM project, however it is extremely important. This step must be done cautiously and in sufficient detail to ensure the final product is exactly what the user wanted. This step includes the market research, the competitive analysis, the distribution channels and the pricing.

2. Delivery System Definition

Hardware compatibility must be considered to keep the cost of hardware to a minimum, and can often be minimized by ensuring compatibility with the currently installed system. Items of consideration should include: for hardware: CPU, monitor, optical disc drive, memory, keyboard/mouse; for software: operating systems, file manager, retrieval, custom.

3. Data Collection

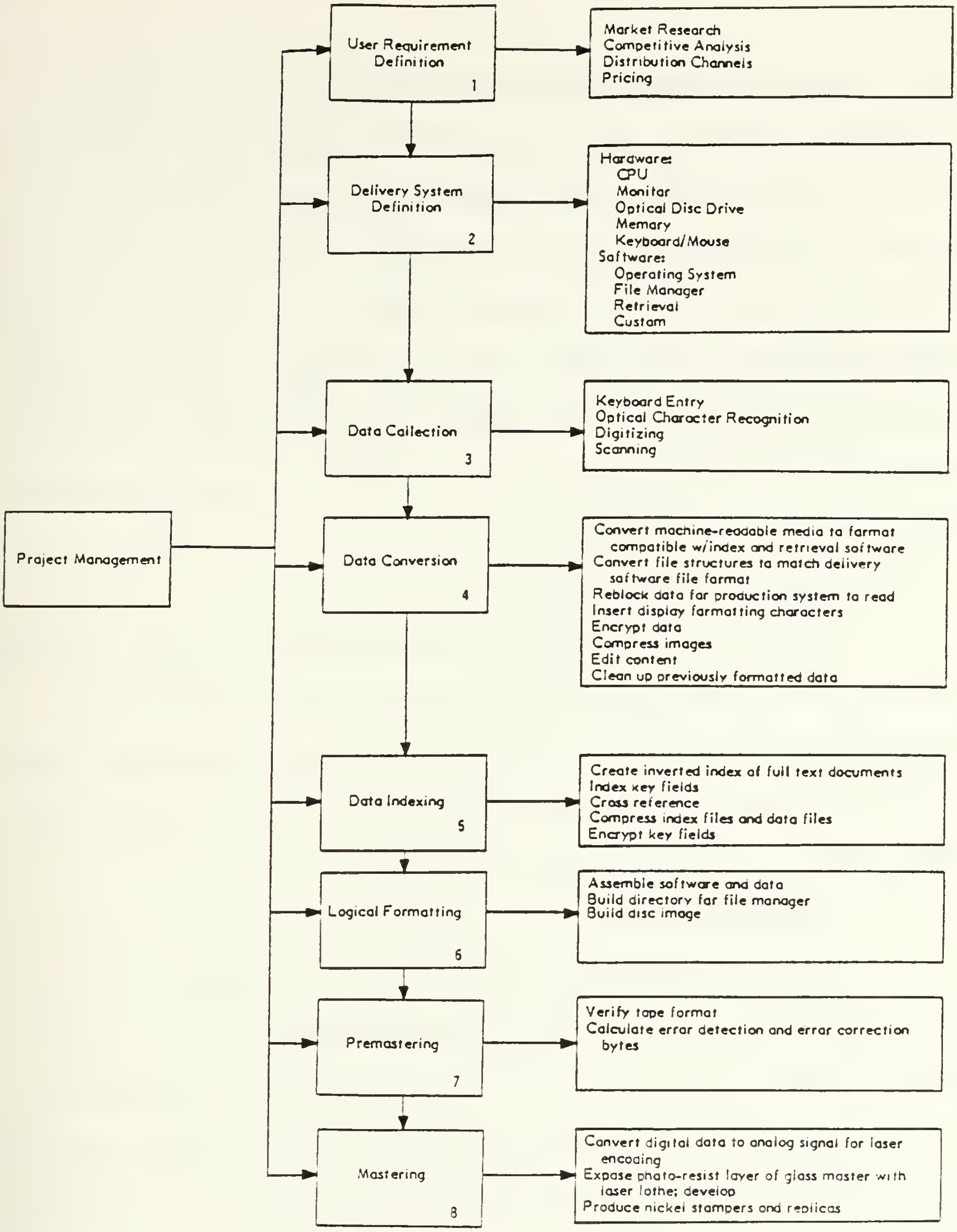
This step can vary from extremely complicated and difficult to almost no effort at all. Much of the data that is desireable to put on CD-ROM is all ready centrally located and it can be readily identified and isolated. This step must consider the possibilities of keyboard entry, optical character recognition, digitizing, and scanning.

4. Data Conversion

This procedure can vary widely, with the most difficult process being the conversion of data currently held in paper form to digital information. Occasionally, the information can be found all ready stored on 1/2 inch magnetic tape and ready for the next step. The data can be on paper in picture or graphic form, on tape in EBCDIC form, on microfiche, on microfilm, on aperture cards, on floppy discs et cetera and thus the process varies and the cost/benefit of each must be carefully weighed. This step includes such things as the conversion of the machine-readable media to a format compatible with the index and retrieval software, conversion of file structures to match the file format, reblocking data, insertion of display formatting characters, encryption of the data, compression of images, and various other editing and alteration techniques.

5. Data Indexing

This involves processing the data and creation of the index file for the key fields. The amount and complexity of this process depends on the nature of the


User Requirement Definition
1
Market Research
Competitive Analysis
Distribution Channels
Pricing
Delivery System Definition
2
Hardware:
CPU
Monitor
Optical Disc Drive
Memory
Keyboard/Mouse
Software:
Operating System
File Manager
Retrieval
Custom
Data Collection
3
Keyboard Entry
Optical Character Recognition
Digitizing
Scanning
Project Management
Data Conversion
4
Convert machine-readable media to format compatible w/index and retrieval software
Convert file structures to match delivery software file format
Reblock data for production system to read
Insert display formatting characters
Encrypt data
Compress images
Edit content
Clean up previously formatted data
Data Indexing
5
Create inverted index of full text documents
Index key fields
Cross reference
Compress index files and data files
Encrypt key fields
Logical Formatting
6
Assemble software and data
Build directory for file manager
Build disc image
Premastering
7
Verify tape format
Calculate error detection and error correction bytes
Mastering
8
Convert digital data to analog signal for laser encoding
Expose photo-resist layer of glass master with laser lathe; develop
Produce nickel stampers and replicas

SOURCE: Reference Technology Inc., Boulder, Colorado

Figure 13. Application Development Process For A CD-ROM Product

data and the number of fields or words that require indexing. Due to the nature of CD-ROM with its three mile track it would take approximately 60 minutes to search the entire three mile distance at 150 KB/sec and therefore the proper indexing is very critical. This step covers not only the inverted index of full text documents, but also the index of key fields, cross referencing, compression and encryption as necessary and desired.

6. Logical Formatting

This step involves the assembly of the software and the data and all of the associated indexes and retrieval structures. The build of the directory for the file manager and the build of the disc image also takes place in this step.

7. Premastering

This is usually done at the publisher or service bureau and involves transferring of all the data to 1/2 inch tapes to be sent off to be mastered. It includes the verification of the tape format and the calculation of the error detection and error correction codes.

8. Mastering

This takes place at a disc factory in a clean environment. It consists of conversion of the digital data on the 1/2 inch tapes to an analog signal for laser encoding followed by the burning of the data onto the glass master by means of a high powered laser. From the glass master a negative impression is taken in metal and used as a stamper, or metal-mother. From the stamper, multiple polycarbonate discs, or replicas, are made and then coated with a thin layer of metal and finally topped with a protective lacquering.

V. APPLICATION DEMONSTRATION (DESIGN TO DELIVERY--A SPECIFIC EXAMPLE)

In the specific example that follows, the hardware and software will be described as well as the database that was mastered to CD-ROM as part of this thesis. The generic procedures previously described in Chapter IV will not be repeated, however the specifics of the application will be covered in this chapter.

A. SPONSOR

Sponsorship for this project was obtained from Naval Supply Systems Command in Washington, D.C. as part of an ongoing review of new technologies. The specific field of study and the resultant application were an outcome of the advertised capability of laser technology to accommodate massive amounts of digital information at reduced cost-per-megabyte values. (See Figure 11) The immediate need as seen by NAVSUP, was to alleviate the problem of over commitment of the installed TANDEM Systems at the 8 Naval Supply Centers (See Table 6). Current systems were overloaded with the Transaction Ledger On Disc (TLOD) database thus precluding the use of the system for other operationally more productive uses.

TABLE 6. NAVAL SUPPLY CENTERS AND DEPOTS

NAVAL SUPPLY CENTERS

1. Charleston, South Carolina
2. Jacksonville, Florida
3. Norfolk, Virginia
4. Oakland, California
5. Puget Sound, Washington
6. San Diego, California
7. Pearl Harbor, Hawaii

DEPOTS

1. Yokosuka, Japan
2. Subic, Philippines
3. Guam

B. DATA SOURCE

Due to it's proximity to the Naval Postgraduate School, the Naval Supply Center at Oakland, California was chosen as the source of the TLOD database and for testing of the application after its completion. The database consists of the first two months, October and November, of the new fiscal year 1987, and contains slightly over 2 million records. In the actual disc, or dataplate, produced only 395.3 Mbytes of the available 540 Mbytes were used.

C. HARDWARE

The Zenith Z-248 was chosen for this application demonstration due to it's role as the "generic" Department of Defense computer. The broad user market included over 1,250 USAFA cadets, over 1,230 USMA cadets, and over 1,301 USNA midshipmen, all newly reporting the respective academies in the fall of 1986. [Ref. 12] This has the tremendous potential of a very familiar medium that can simply be expanded through the use of additional hardware such as the CD-ROM Disc Drive.

In a recent survey it was estimated that among government computers over 36.5 percent are used 4 hours or less out of every work day. [Ref. 13] This would conveniently allow for another use, or share use, of the microcomputer such as a CD-ROM application.

* Zenith Z-248 PC (IBM PC/AT Compatible) with :
  -20 Mbyte Winchester Drive
  -1 360K Double-sided, double-density, soft-sectored
  -5 1/4 inch floppy disk drive
  -640K RAM
  -Intel's 80286 16-bit Microprocessor
  -8 MHZ Systems Clock

* Zenith RGB/ENHANCED COLOR MONITOR

* CLASIX^{tm} DataDrive^{tm} Series 500 (see Table 7 for summary specifications)

D. SOFTWARE

* Standard File Manager
* Key Record Manager
* Application Specific file access software

E. CD-ROM

- Transaction Ledger on Compact Disc (TLOCD)

TABLE 7. CLASIX DATADRIVE PERFORMANCE CHARACTERISTICS

PERFORMANCE CHARACTERISTICS OF THE
CLASIX DATADRIVE SERIES 500 AND THE
CD-ROM DATAPLATE
(as provided by Reference Technology, Inc. literature)

Formatted Capacity:	
Capacity Per CD-ROM DataPlate	540 MBytes
Number of Recorded Surfaces	1
Number of Blocks	270,000
Bytes Per Block (Formatted)	2048
Performance:	
Average Seek Time (Motion & Settling)	1.0 sec
Average Rotational Latency	70 msec (inner) 150 msec (outer)
Average Total Access Time	900 sec
Rotational Speed (CLV)	220-480 rpm
Sustained Data Rate	150 KBytes/sec
MTBF	10,000 Power on Hours
Error Rate (Output)	< 1 per 10^{12} Bytes
Functional:	
CD-ROM DataPlate Size	
CD-ROM DataPlate Type	4.72 in (12 cm)
Interface	Std Prerecorded
Software I/O Driver	IBM PC Parallel
	IBM PC DOS Compatible
Weight	
Disc Loading	13.5 lbs/6 kg
	Horizontal Front Loading
Power Requirements	
Dimensions (H X W X L)	120V/60Hz/25W
	3.3in X 17.2in X 11.4in

F. COST [Ref.14]

The following paragraph, as well as Table 8, is a quote from a letter by Reference Technology, Inc. regarding the initial cost for the project and an estimate for follow-on projects not requiring the development, layout and hardware required for the first.

"The formula for calculating the cost of the indexing set up and indexing of the fields is below:

$1,500.00 Indexing set up + $.50 per index per 1,000 records

$1,500.00 + ($.5 x #1 X 1KR) = Total Cost

$.50 x 6 indexed fields = $3.00 x 1,077K records = $3,231.00

Indexing Set Up = $1,500.00

Indexing = $3,231.00

Indexing Total Cost $4,731.00

Using the above formula, you can calculate the cost of adding 1,000,000 records to be $3,000.00.

Also, the addition or deletion of indexed fields greatly changes the cost (see below).

$1,500 + (.5 x 4 indexed fields - $2.00 x 1,077K) = $3,654.00

The following is for the conversion of the NSC historical purchasing database (Transaction Ledger On Disc (TLOD)) for the months of October and November 1986, to CD-ROM. The quotation covers the data for the month of October and allows for the addition of similar additional data (November TLOD) at costs outlined below. The cost is also based on creating six indexed fields for retrieval of the data."

TABLE 8. COST OF TLOCD APPLICATION

	INITIAL CD-ROM	NEW CD-ROM ONE AT A TIME
	**********************	
Application Development	$4,400.00	-0-
Indexing Layout	$1,500.00	-0-
Indexing Set-Up & Indexing	$4,731.00	$4,731.00
Additional 1 Million Records	$3,000.00	$3,000.00
Disk Preparation	$4,000.00	$2,500.00
Mastering (20 day turnaround)	$4,400.00	$4,400.00
Replicas (50 at $20 each)	$1,000.00	$1,000.00
CLASIX 500 DataDrive	$ 900.00	-0-
Laser Printer	$2,850.00	-0-
File Manager Software (each)	$ 58.90	-0-
Key Manager Software (each)	$ 151.90	-0-
= = = = = = = = = = = = = = = =	= = = = = = = =	= = = = = = = =
TOTAL......................	$26,990.80	$15,631.00

VI. SUMMARY

A. CONCLUSION

Current investigation into the area of optical disc technology in the U.S. Navy includes a project by NAVSEA called Computer-Aided Technical Information System (CATIS) primarily involved with the placing of engineering technical manuals onto optical laser disc for the Trident-Class Submarines. Another ongoing investigation is the Engineering Data Management Information and Control System (EDMICS) project at the Naval Ship Weapons System Engineering Station (NSWSES) in Port Hueneme, California which is involved with placing the engineering diagrams onto optical laser disc for use by major industrial facilities.

Numerous applications in the civilian community have migrated to optical laser disc, however most applications are still geared to specialty areas and include such things as the MICROMEDEX^{tm} Computerized Clinical Information System (CCIS). This is the first medical file on CD-ROM and it consists of four databases which are frequently used in hospital emergency rooms for the identification and treatment of abuses of toxic substances and prescription drugs, as well as for emergency treatment information.

Another example is:

> Image Conversion Technologies has been awarded a $2.5 million subcontract by Capital Systems Inc. for image management services for the Naval Print on Demand System.
>
> To support the effort, ICT will digitize about 1.8 million pages of military specifications to be stored on two 80-gigabyte optical disc library units. ICT's Data Visual Management System will be used for storage, indexing and retrieval of all documents to be printed, while its order-entry system will be used to manage orders and perform administrative operations. All processing and job control will be performed by a dual Digital Equipment Corporation VAX 11/780 cluster configured by ICT.
>
> The anticipated printing volume is 225,000 pages per day with a required turn-around time of two days. [Ref. 15]

The technology works, and any paper file is a candidate for conversion to optical disc, however the question remains--does it work in "our" environment?

There are some who are reluctant to commit themselves to optical discs for permanent storage of historical documents. According to the National Research Council's report, "Preservation of Historical Records", the rapid pace of change in hardware and software technology suggests that it may be impossible to read the historical records in the centuries to come. Although present advantages appear to be overwhelming, such long term archives could potentially be forced to commit themselves to an expensive file conversion process every 10 to 20 years. [Ref. 16]

B. RECOMMENDATION

The new application was completed and is called Transaction Ledger On Compact Disc (TLOCD) (pronounced "T-locked"). (See Figure 14) It was compared in parallel with the current TLOD system at NSC Oakland and the results were essentially identical and access times were similar. The advantages are as previously discussed.

One of the deleterious aspects to the successful introduction of TLOCD is simply the newness of the system and the technology and the scepticism with which it is greeted by the users. A facility that currently has an on-going, and modestly effective, program such as the current TLOD does not often see the necessity for change even though benefits are evident. There must be a process of unfreezing in the sense of current procedures, followed by the change and then a process of refreezing in the newly established pattern.

For future consideration, especially with the tremendous storage capacity and the small size of the CD-ROM, it may be desireable to place the noun name, or nomenclature, on the disc, or discs, in addition to the NIIN. This would enable direct and positive correlation without reference to other publications or sources. Still another application could be the presentation of the associated graphics for the NIIN's to assist in ordering and identification of the exact equipment, part, et cetera.

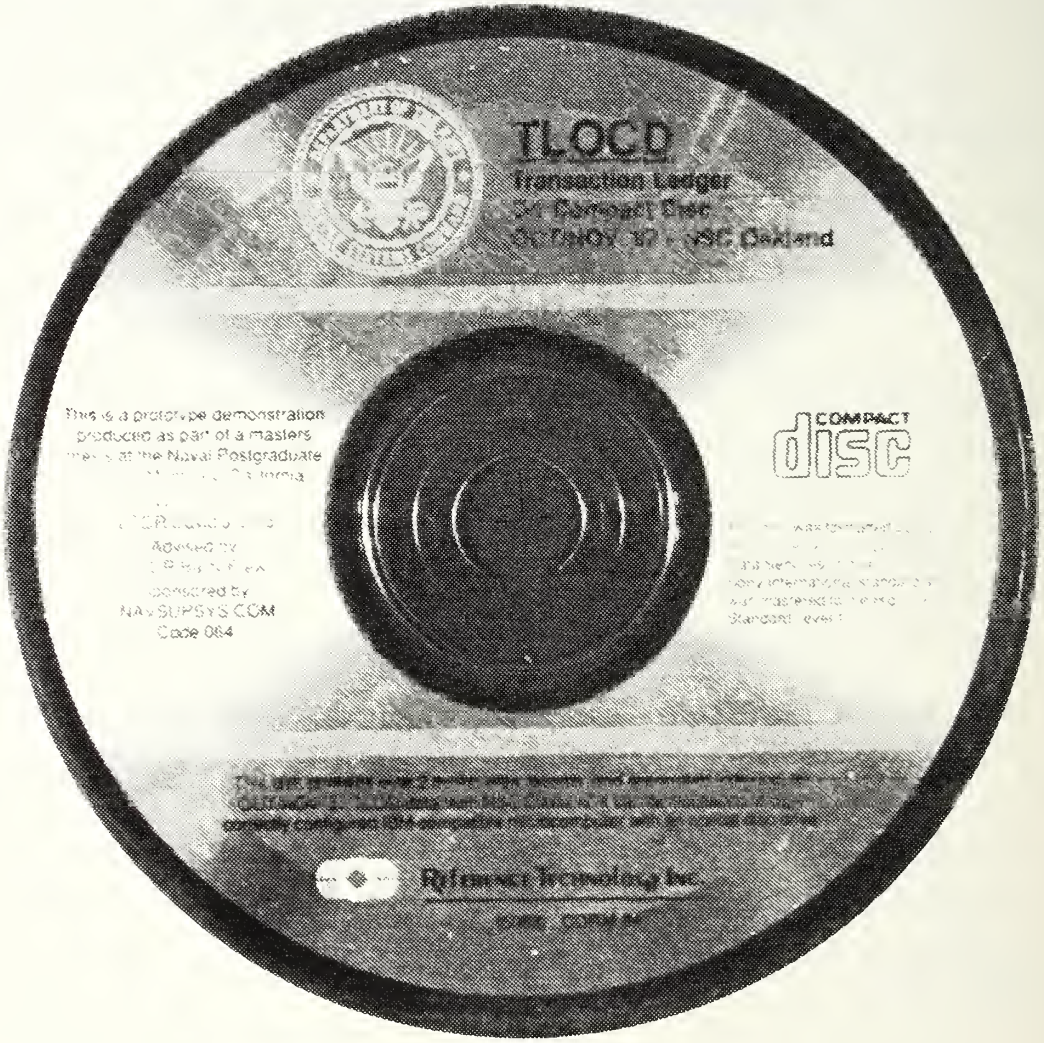

TLOCD
Transaction Ledger
On Compact Disc
OCT/NOV '87 - NSC Oakland
This is a prototype demonstration
produced as part of a masters
thesis at the Naval Postgraduate
Advised by
Sponsored by
NAVSUPSYS COM
Code 064
COMPACT
disc
Standard level
Reference Technology Inc.

Figure 14. Transaction Ledger On Compact Disc (TLOCD) Dataplate - OCT/NOV '87 NSC Oakland

APPENDIX A

SCREEN DUMPS FROM THE CURRENT TLOD SYSTEM

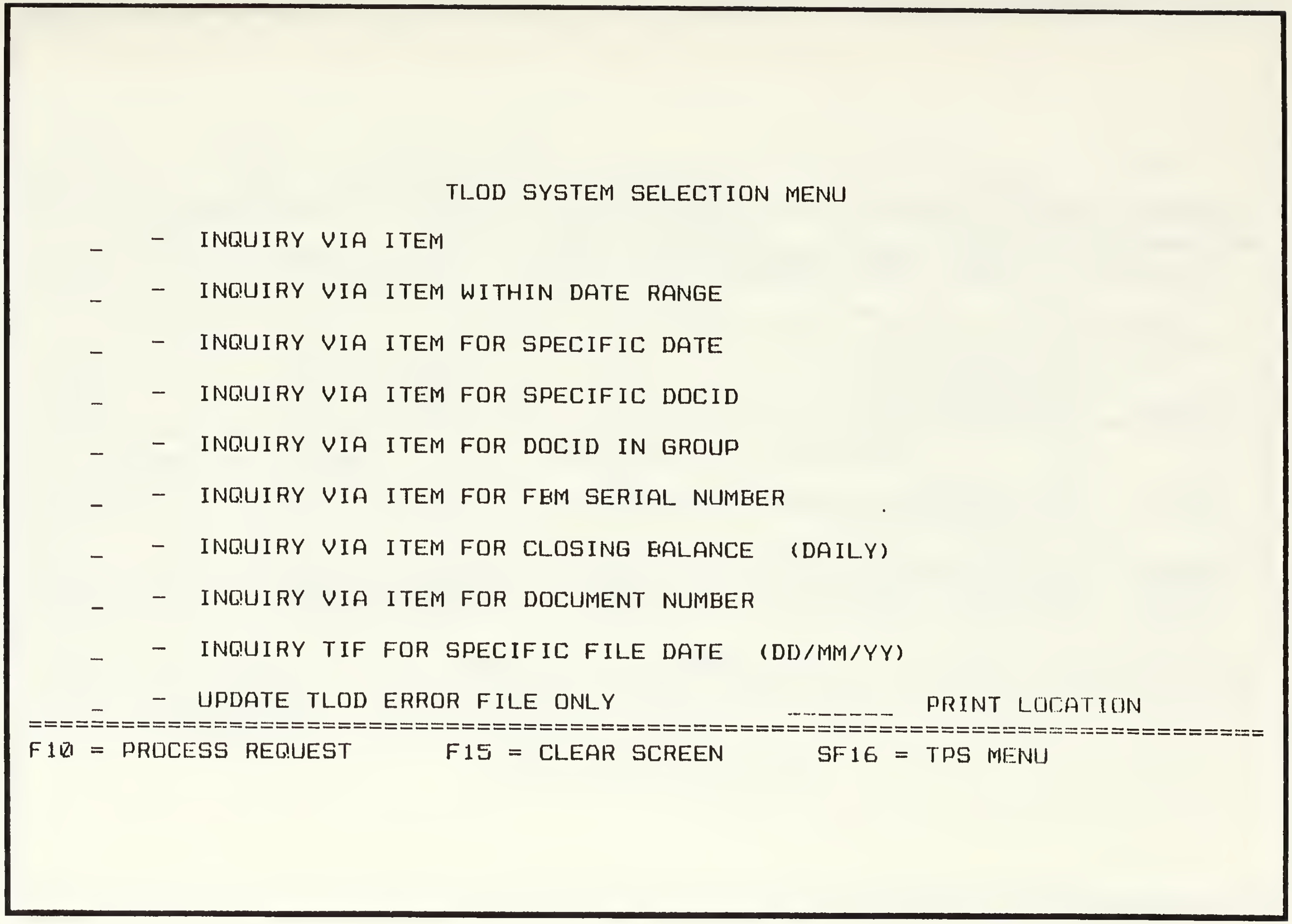
This appendix includes the screen dumps from the current TLOD system in use at the Naval Supply Center, Oakland, California. The initial screens/menus are presented, as well as sample results from each inquiry.

A listing of the screen dumps can be found at the beginning of the appendix on page 66.

Listing Of Screen Dumps In Appendix A

Screen	**Title**
1	TLOD System Selection Menu
2	TLOD Inquiry Via Item
2A	TLOD Inquiry Via Item (Window A Results)
2B	TLOD Inquiry Via Item (Window B Results)
3	TLOD Inquiry Via Item (Selecting "Y" for Causative Research)
3A	TLOD Inquiry Via Item (Short Form Results)
4	TLOD Inquiry Via Item Within Date Range
4A	TLOD Inquiry Via Item Within Date Range (Results)
5	TLOD Inquiry Via Item For Specific Date
5A	TLOD Inquiry Via Item For Specific Date (Results)
6	TLOD Inquiry Via Item For Specific DOCID
6A	TLOD Inquiry Via Item For Specific DOCID (Results)
7	TLOD Inquiry Via Item For DOCID Group
7A	TLOD Inquiry Via Item For DOCID Group (With Selected DOCID's Displayed)
7B	TLOD Inquiry Via Item For DOCID Group (Results)
8	TLOD Inquiry Via Item For FBM Serial Number
9	TLOD Inquiry Via Item For Closing Balance (Daily)
9A	TLOD Inquiry Via Item For Closing Balance (Results)
10	TLOD Inquiry Via Item For Document Number
10A	TLOD Inquiry Via Item For Document Number (Window A Results)
10B	TLOD Inquiry Via Item For Document Number (Window B Results)
11	TLOD Inquiry Via Item For Document Number (Selecting "Y" For Causative Research)
11A	TLOD Inquiry Via Item For Document Number (Short Form Results)
12	TLOD Inquiry TIF For Specific File Date
12A	TLOD Inquiry TIF For Specific File Date (Results)
13	TLOD System Selection Menu (Reflects Access To Last Menu Selection As Not Authorized)

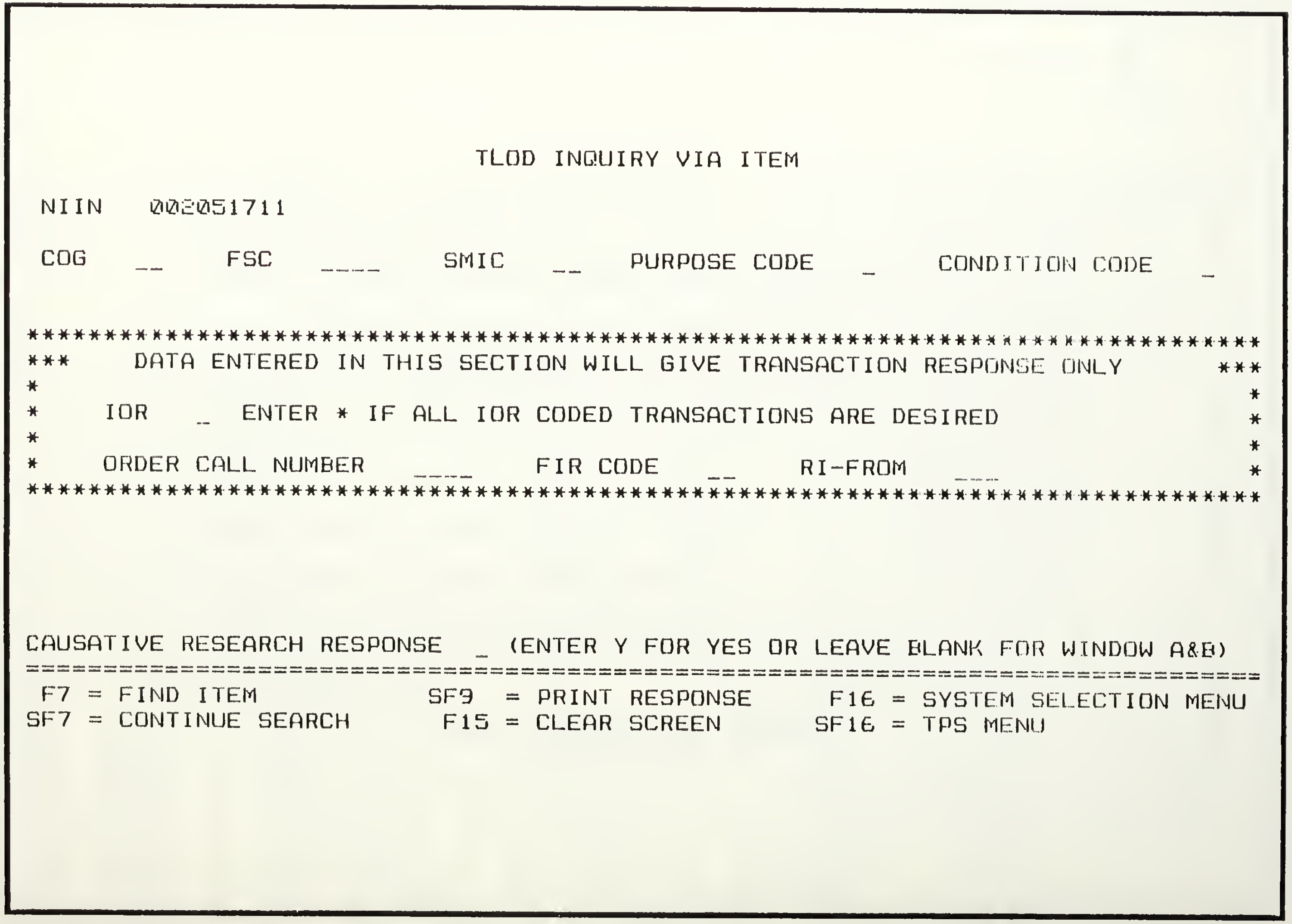
TLOD SYSTEM SELECTION MENU



```
                   TLOD SYSTEM SELECTION MENU
 _  -  INQUIRY VIA ITEM
 _  -  INQUIRY VIA ITEM WITHIN DATE RANGE
 _  -  INQUIRY VIA ITEM FOR SPECIFIC DATE
 _  -  INQUIRY VIA ITEM FOR SPECIFIC DOCID
 _  -  INQUIRY VIA ITEM FOR DOCID IN GROUP
 _  -  INQUIRY VIA ITEM FOR FBM SERIAL NUMBER
 _  -  INQUIRY VIA ITEM FOR CLOSING BALANCE  (DAILY)
 _  -  INQUIRY VIA ITEM FOR DOCUMENT NUMBER
 _  -  INQUIRY TIF FOR SPECIFIC FILE DATE  (DD/MM/YY)
 _  -  UPDATE TLOD ERROR FILE ONLY            _______  PRINT LOCATION
===============================================================================
F10 = PROCESS REQUEST      F15 = CLEAR SCREEN      SF16 = TPS MENU
```

Screen 1

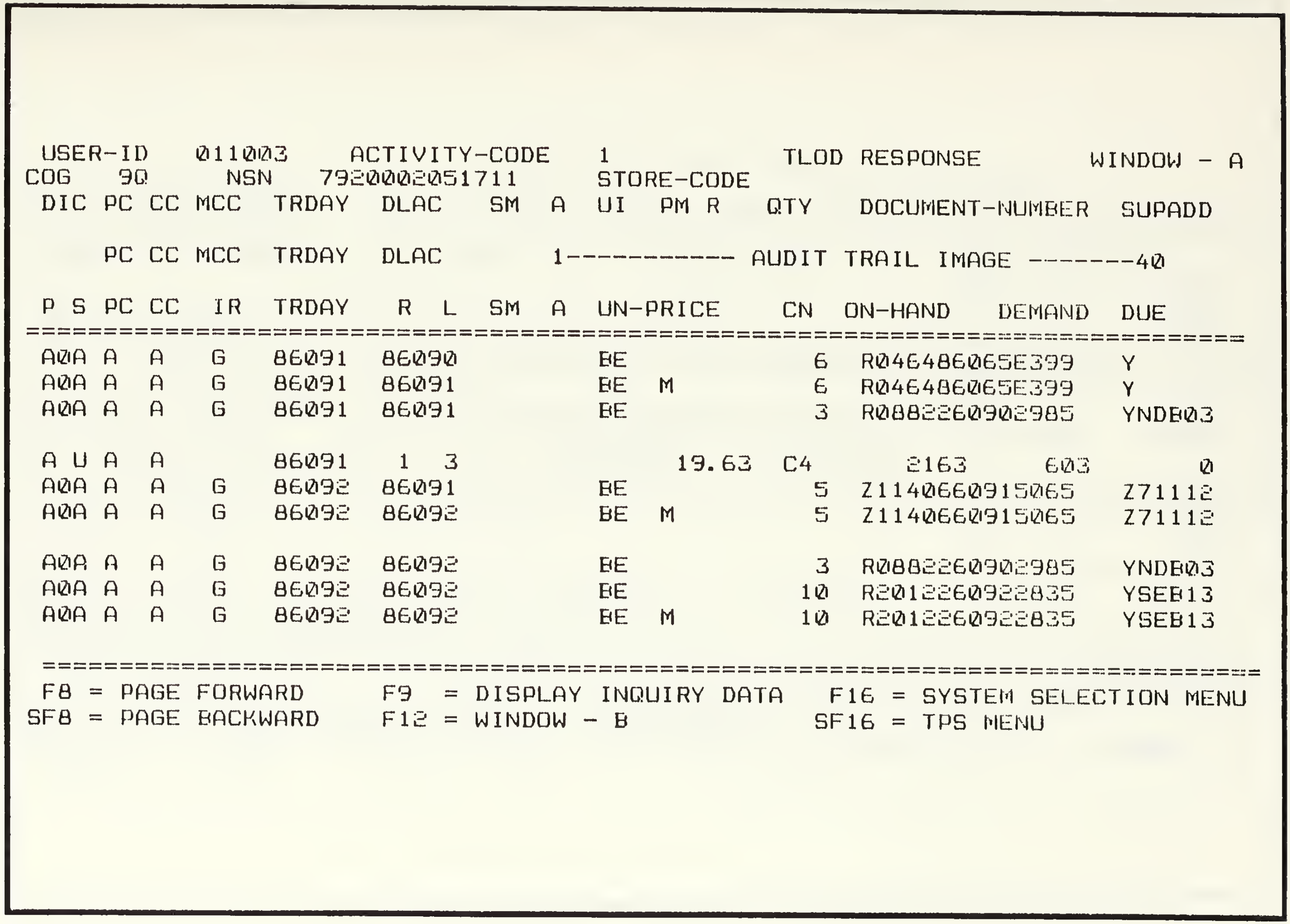
TLOD INQUIRY VIA ITEM



```
                          TLOD INQUIRY VIA ITEM

 NIIN   002051711

 COG    __    FSC   ____    SMIC   __   PURPOSE CODE   _   CONDITION CODE   _

*****************************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY   ***
*                                                                           *
*    IOR   _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED             *
*                                                                           *
*    ORDER CALL NUMBER   ____    FIR CODE   __    RI-FROM   ___             *
*****************************************************************************



CAUSATIVE RESEARCH RESPONSE   _ (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
=============================================================================
 F7  = FIND ITEM           SF9  = PRINT RESPONSE     F16  = SYSTEM SELECTION MENU
SF7  = CONTINUE SEARCH      F15 = CLEAR SCREEN      SF16 = TPS MENU
```

Screen 2

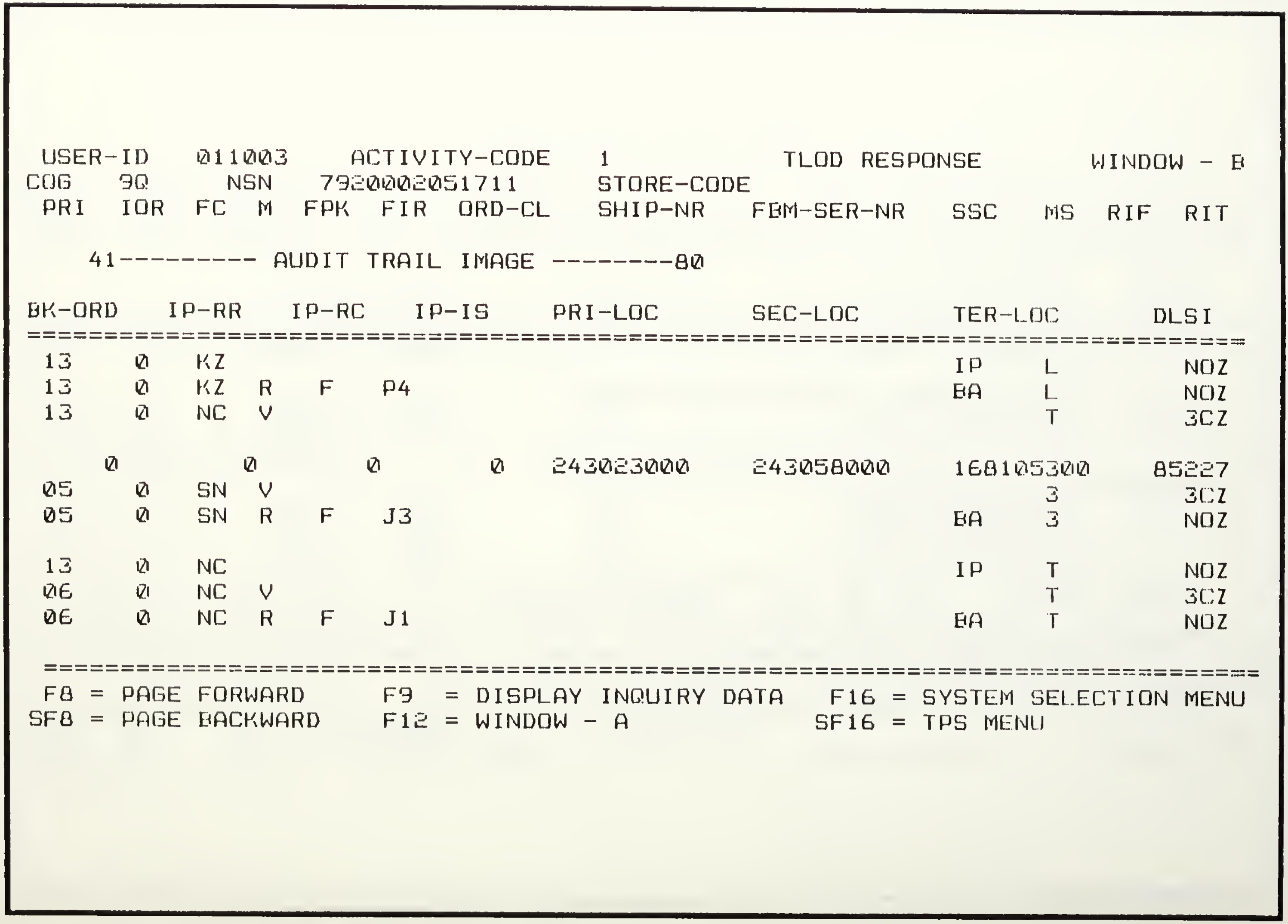
TLOD INQUIRY VIA ITEM
(WINDOW A RESULTS)



```
 USER-ID    011003     ACTIVITY-CODE    1            TLOD RESPONSE        WINDOW - A
COG    9Q      NSN    7920002051711      STORE-CODE
 DIC  PC  CC  MCC   TRDAY   DLAC    SM   A   UI   PM  R    QTY    DOCUMENT-NUMBER   SUPADD

      PC  CC  MCC   TRDAY   DLAC         1------------ AUDIT TRAIL IMAGE --------40

 P  S  PC  CC   IR   TRDAY    R   L   SM   A   UN-PRICE     CN   ON-HAND    DEMAND   DUE
=====================================================================================
 A0A  A    A    G    86091   86090           BE               6   R046486065E399    Y
 A0A  A    A    G    86091   86091           BE   M           6   R046486065E399    Y
 A0A  A    A    G    86091   86091           BE               3   R0882260902985    YNDB03

 A  U  A   A         86091     1   3               19.63   C4      2163      603        0
 A0A  A    A    G    86092   86091           BE               5   Z1140660915065    Z71112
 A0A  A    A    G    86092   86092           BE   M           5   Z1140660915065    Z71112

 A0A  A    A    G    86092   86092           BE               3   R0882260902985    YNDB03
 A0A  A    A    G    86092   86092           BE              10   R2012260922835    YSEB13
 A0A  A    A    G    86092   86092           BE   M          10   R2012260922835    YSEB13

=====================================================================================
 F8  = PAGE FORWARD      F9  = DISPLAY INQUIRY DATA    F16  = SYSTEM SELECTION MENU
SF8  = PAGE BACKWARD     F12 = WINDOW - B             SF16  = TPS MENU
```

Screen 2A

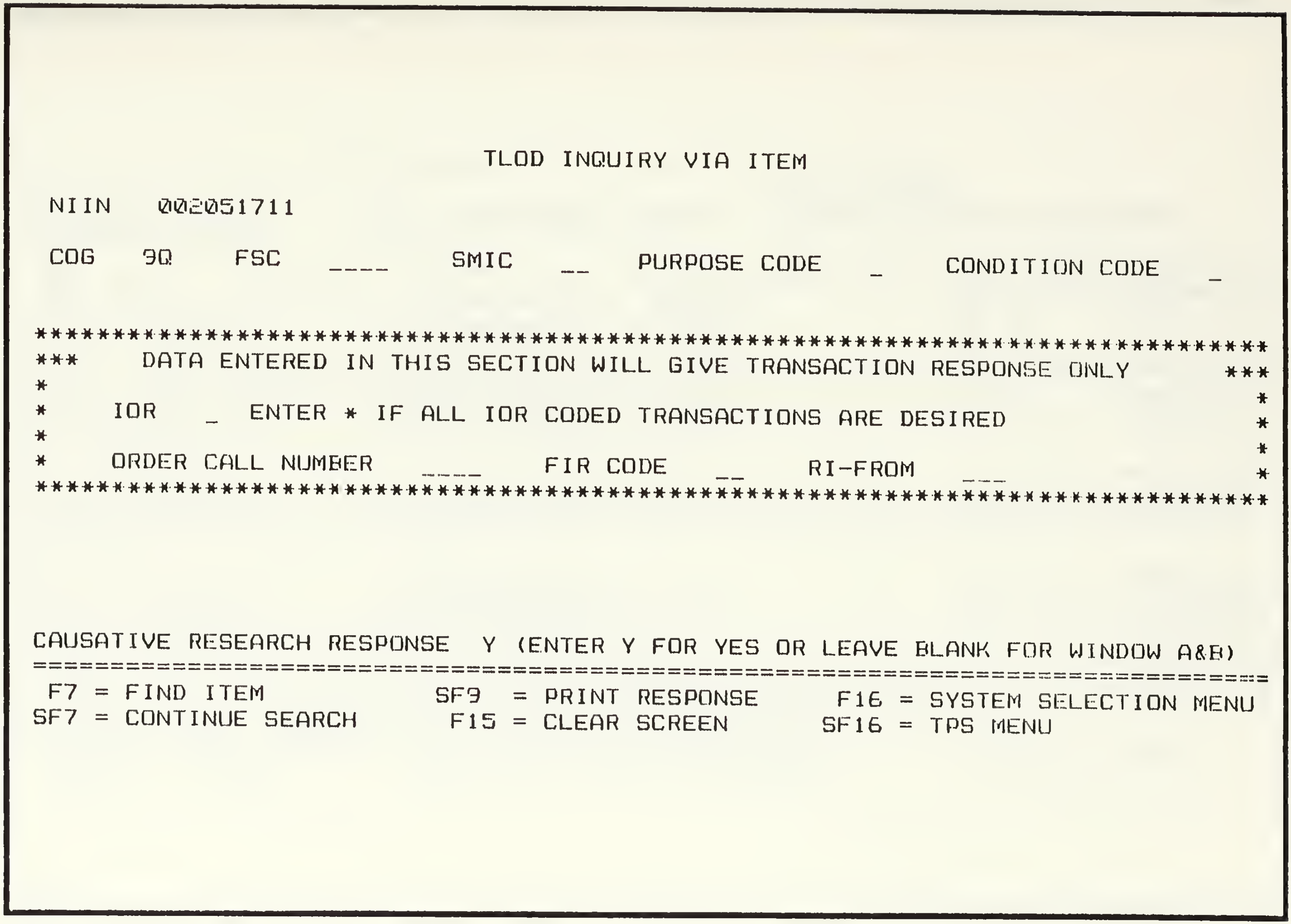
TLOD INQUIRY VIA ITEM
(WINDOW B RESULTS)



```
 USER-ID    011003    ACTIVITY-CODE   1            TLOD RESPONSE        WINDOW - B
COG    9Q      NSN    7920002051711     STORE-CODE
 PRI   IOR   FC   M   FPK   FIR   ORD-CL    SHIP-NR    FBM-SER-NR    SSC    MS    RIF   RIT

    41--------- AUDIT TRAIL IMAGE ---------80

BK-ORD     IP-RR     IP-RC     IP-IS     PRI-LOC       SEC-LOC       TER-LOC       DLSI
====================================================================================
 13      0     KZ                                                   IP      L          NOZ
 13      0     KZ   R     F     P4                                  BA      L          NOZ
 13      0     NC   V                                                       T          3CZ

     0          0          0          0    243023000     243058000    168105300     85227
 05      0     SN   V                                                       3          3CZ
 05      0     SN   R     F     J3                                  BA      3          NOZ

 13      0     NC                                                   IP      T          NOZ
 06      0     NC   V                                                       T          3CZ
 06      0     NC   R     F     J1                                  BA      T          NOZ

 ====================================================================================
 F8  = PAGE FORWARD      F9  = DISPLAY INQUIRY DATA     F16 = SYSTEM SELECTION MENU
SF8  = PAGE BACKWARD     F12 = WINDOW - A              SF16 = TPS MENU
```

Screen 2B

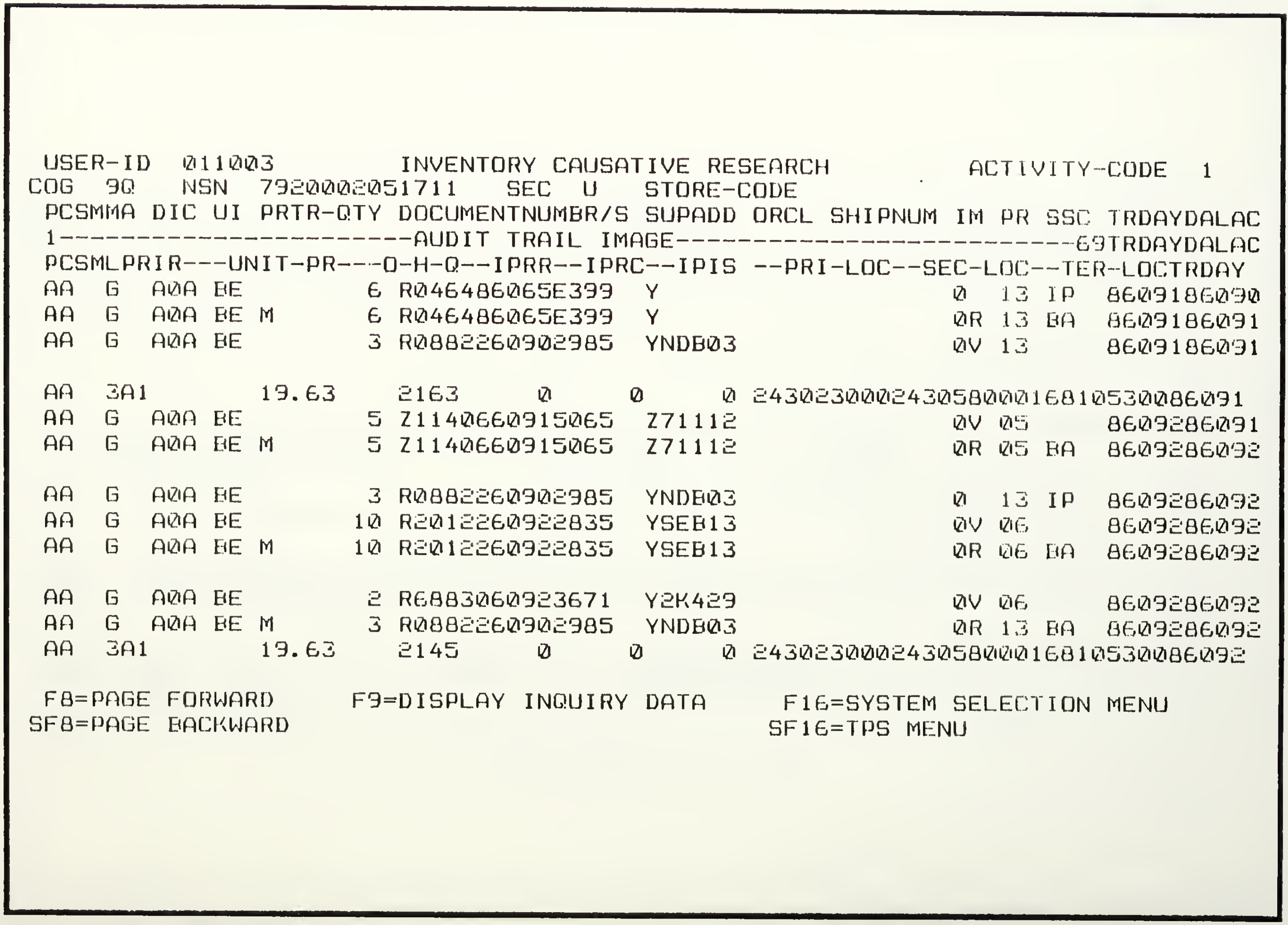
TLOD INQUIRY VIA ITEM
(SELECTING "Y" FOR CAUSATIVE RESEARCH)



```
                             TLOD INQUIRY VIA ITEM

  NIIN    002051711

  COG    9Q     FSC    ____     SMIC    __    PURPOSE CODE    _    CONDITION CODE    _

********************************************************************************
***     DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY        ***
*                                                                               *
*    IOR     _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED               *
*                                                                               *
*    ORDER CALL NUMBER   ____     FIR CODE    __     RI-FROM   ___              *
********************************************************************************




CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
================================================================================
 F7 = FIND ITEM             SF9  = PRINT RESPONSE      F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH        F15 = CLEAR SCREEN       SF16 = TPS MENU
```

Screen 3

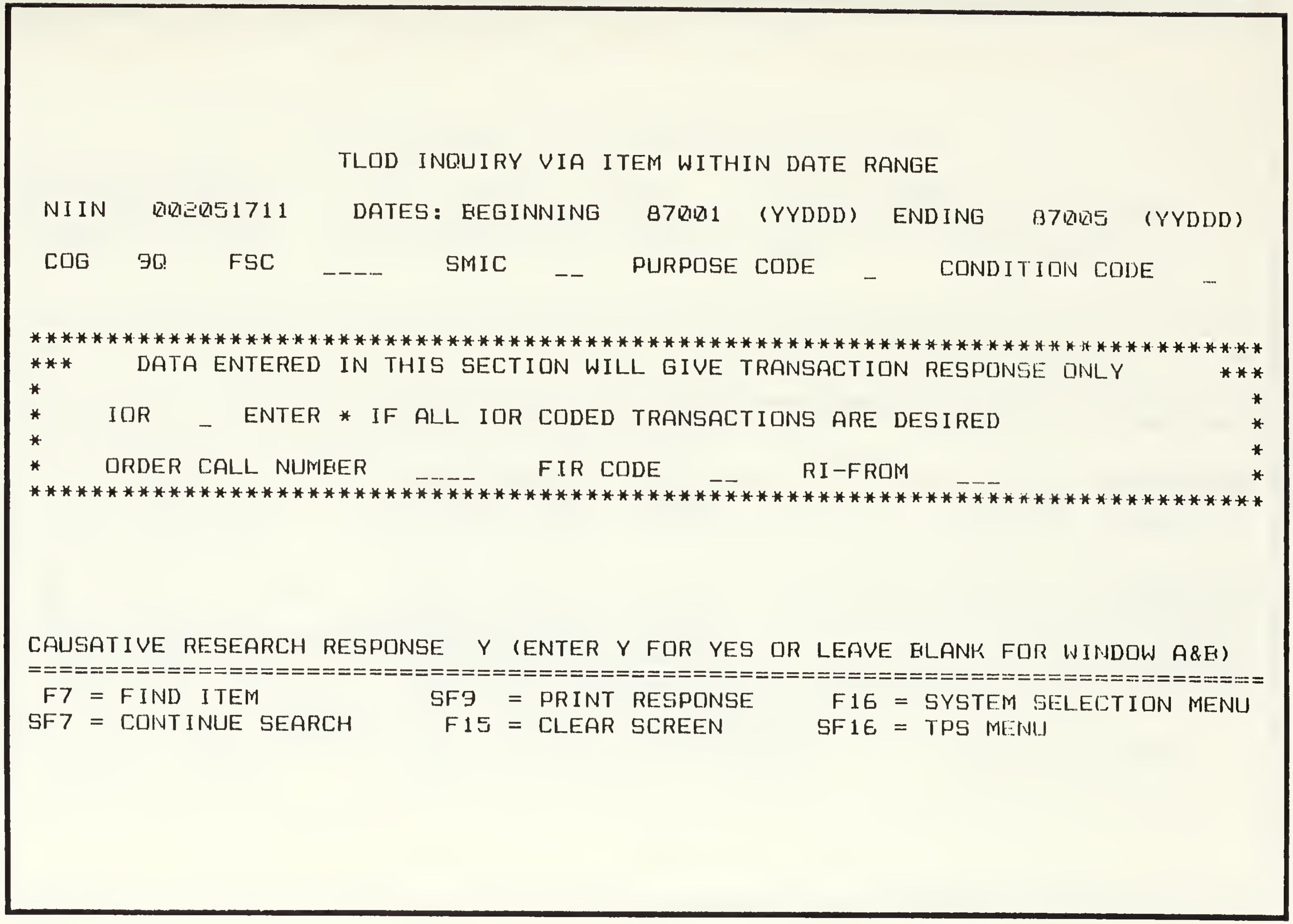
TLOD INQUIRY VIA ITEM
(SHORT FORM RESULTS)



```
 USER-ID  011003         INVENTORY CAUSATIVE RESEARCH         ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711    SEC  U   STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1-------------------AUDIT TRAIL IMAGE-------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA   G   A0A BE         6 R046486065E399  Y                      0  13 IP  8609186090
 AA   G   A0A BE M       6 R046486065E399  Y                      0R 13 BA  8609186091
 AA   G   A0A BE         3 R088226090298S  YNDB03                 0V 13     8609186091

 AA   3A1        19.63    2163     0      0     0 24302300024305800016810530086091
 AA   G   A0A BE         5 Z114066091506S  Z71112                 0V 05     8609286091
 AA   G   A0A BE M       5 Z114066091506S  Z71112                 0R 05 BA  8609286092

 AA   G   A0A BE         3 R088226090298S  YNDB03                 0  13 IP  8609286092
 AA   G   A0A BE        10 R201226092283S  YSEB13                 0V 06     8609286092
 AA   G   A0A BE M      10 R201226092283S  YSEB13                 0R 06 BA  8609286092

 AA   G   A0A BE         2 R688306092367l  Y2K429                 0V 06     8609286092
 AA   G   A0A BE M       3 R088226090298S  YNDB03                 0R 13 BA  8609286092
 AA   3A1        19.63    2145     0      0     0 24302300024305800016810530086092

 F8=PAGE FORWARD      F9=DISPLAY INQUIRY DATA      F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                                 SF16=TPS MENU
```

Screen 3A

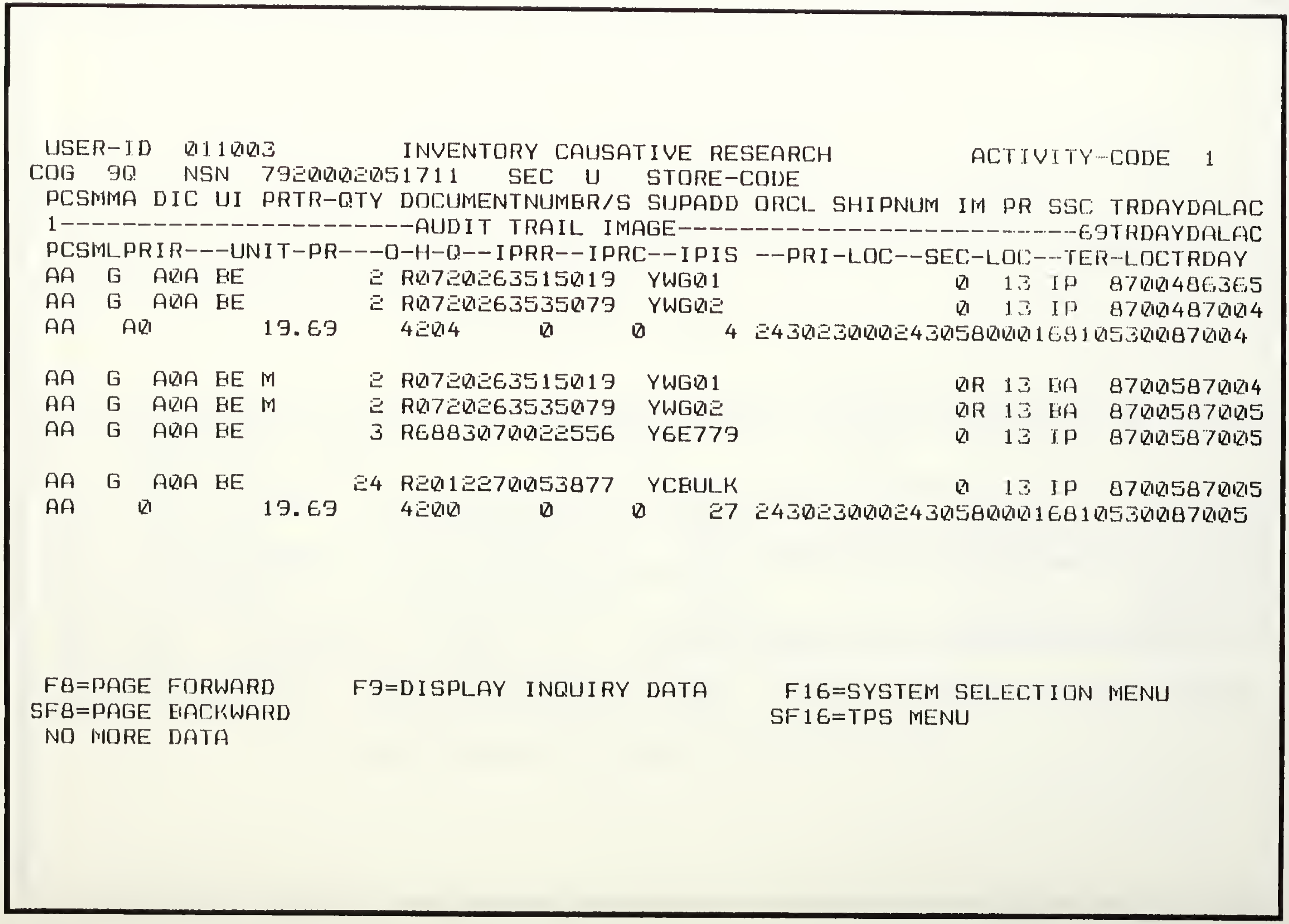
TLOD INQUIRY VIA ITEM WITHIN DATE RANGE



```
                    TLOD INQUIRY VIA ITEM WITHIN DATE RANGE

 NIIN   002051711    DATES: BEGINNING   87001  (YYDDD)  ENDING   87005  (YYDDD)

 COG    9Q    FSC   ____    SMIC   __   PURPOSE CODE   _   CONDITION CODE   _


************************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY     ***
*                                                                      *
*    IOR   _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED        *
*                                                                      *
*    ORDER CALL NUMBER   ____    FIR CODE   __    RI-FROM   ___        *
************************************************************************




CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
========================================================================
 F7 = FIND ITEM            SF9  = PRINT RESPONSE      F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH       F15 = CLEAR SCREEN       SF16 = TPS MENU
```

Screen 4

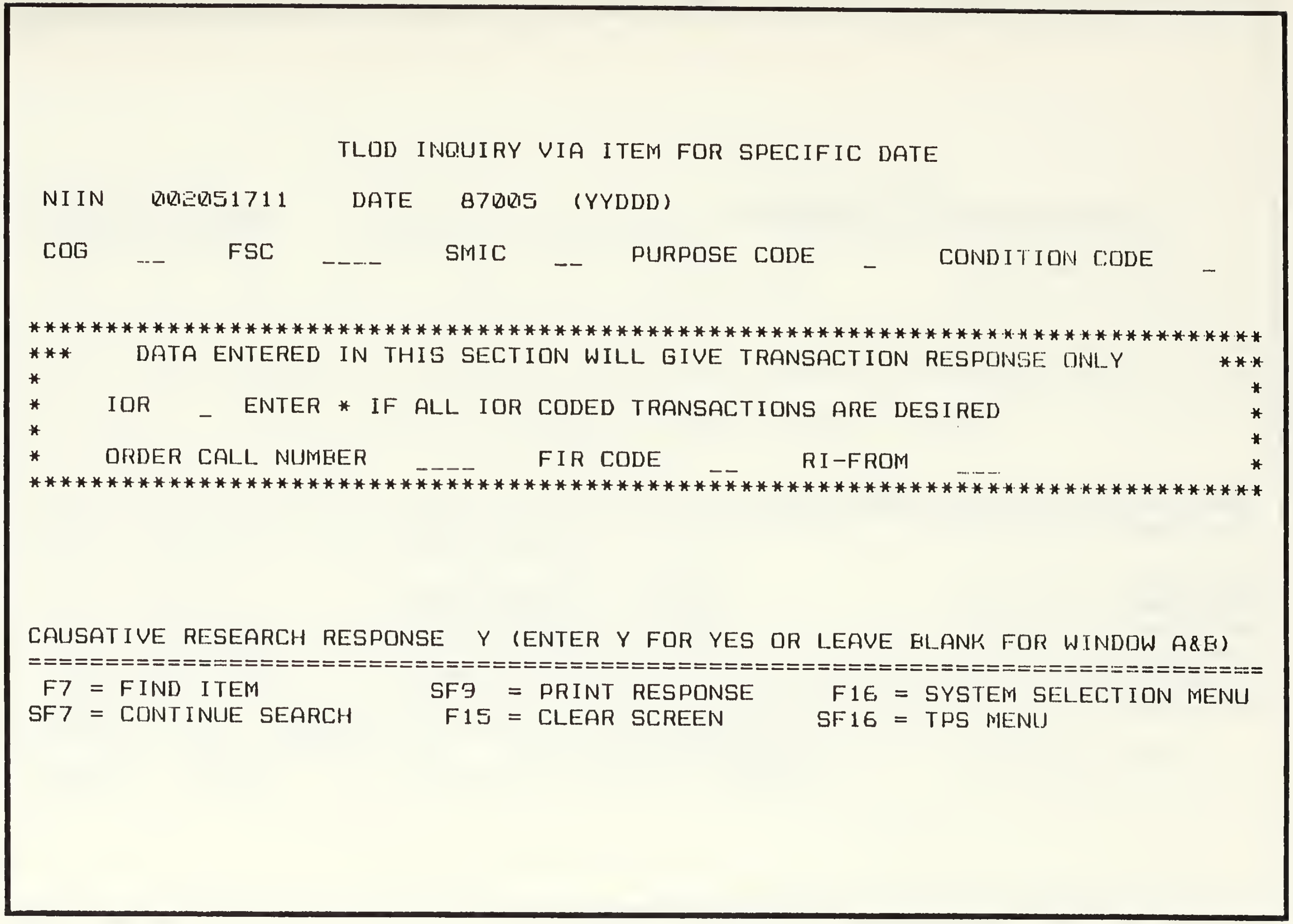
TLOD INQUIRY VIA ITEM WITHIN DATE RANGE
(RESULTS)



```
 USER-ID  011003          INVENTORY CAUSATIVE RESEARCH          ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711   SEC  U   STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1-----------------------AUDIT TRAIL IMAGE----------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA   G   A0A BE          2 R0720263515019  YWG01                   0  13 IP  8700486365
 AA   G   A0A BE          2 R0720263535079  YWG02                   0  13 IP  8700487004
 AA    A0        19.69     4204      0      0     4 243023000243058000168105300087004

 AA   G   A0A BE M        2 R0720263515019  YWG01                   0R 13 BA  8700587004
 AA   G   A0A BE M        2 R0720263535079  YWG02                   0R 13 BA  8700587005
 AA   G   A0A BE          3 R6883070022556  Y6E779                  0  13 IP  8700587005

 AA   G   A0A BE         24 R2012270053877  YCBULK                  0  13 IP  8700587005
 AA     0        19.69     4200      0      0    27 243023000243058000168105300087005



 F8=PAGE FORWARD      F9=DISPLAY INQUIRY DATA     F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                                 SF16=TPS MENU
 NO MORE DATA
```

Screen 4A

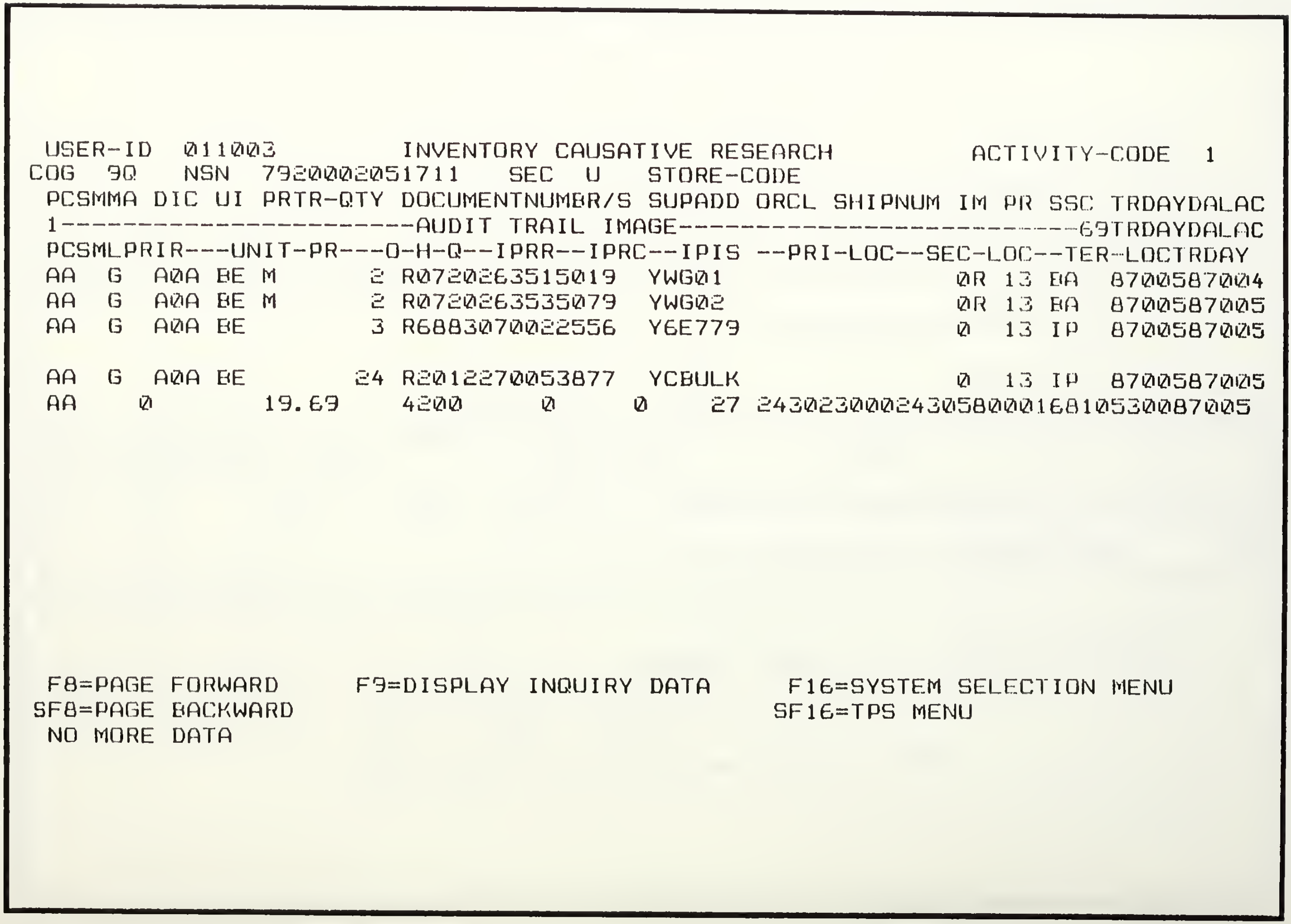
TLOD INQUIRY VIA ITEM FOR SPECIFIC DATE



```
                  TLOD INQUIRY VIA ITEM FOR SPECIFIC DATE

 NIIN   002051711    DATE   87005  (YYDDD)

 COG   __     FSC   ____     SMIC   __    PURPOSE CODE   _    CONDITION CODE   _


******************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY    ***
*                                                                *
*    IOR   _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED   *
*                                                                *
*    ORDER CALL NUMBER   ____     FIR CODE   __    RI-FROM   ___   *
******************************************************************



CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
==================================================================
 F7 = FIND ITEM             SF9  = PRINT RESPONSE     F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH        F15 = CLEAR SCREEN      SF16 = TPS MENU
```

Screen 5

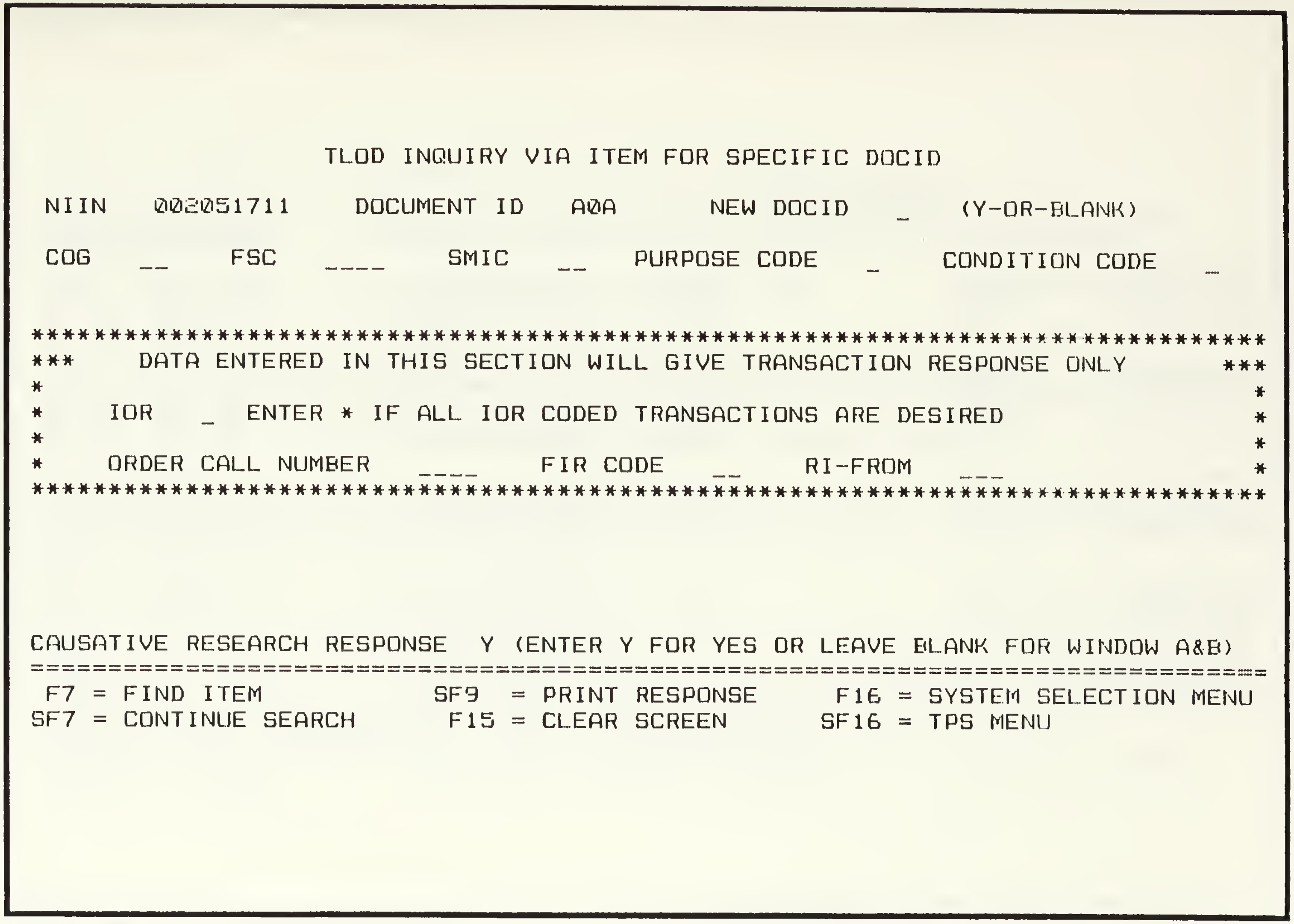
TLOD INQUIRY VIA ITEM FOR SPECIFIC DATE
(RESULTS)



```
 USER-ID  011003        INVENTORY CAUSATIVE RESEARCH         ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711   SEC  U   STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1-----------------------AUDIT TRAIL IMAGE--------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA  G  A0A BE M      2 R0720263515019  YWG01               0R 13 BA  8700587004
 AA  G  A0A BE M      2 R0720263535079  YWG02               0R 13 BA  8700587005
 AA  G  A0A BE        3 R6883070022556  Y6E779              0  13 IP  8700587005

 AA  G  A0A BE       24 R2012270053877  YCBULK              0  13 IP  8700587005
 AA     0       19.69   4200     0     0    27 24302300024305800016810530087005



 F8=PAGE FORWARD     F9=DISPLAY INQUIRY DATA     F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                               SF16=TPS MENU
 NO MORE DATA
```

Screen 5A

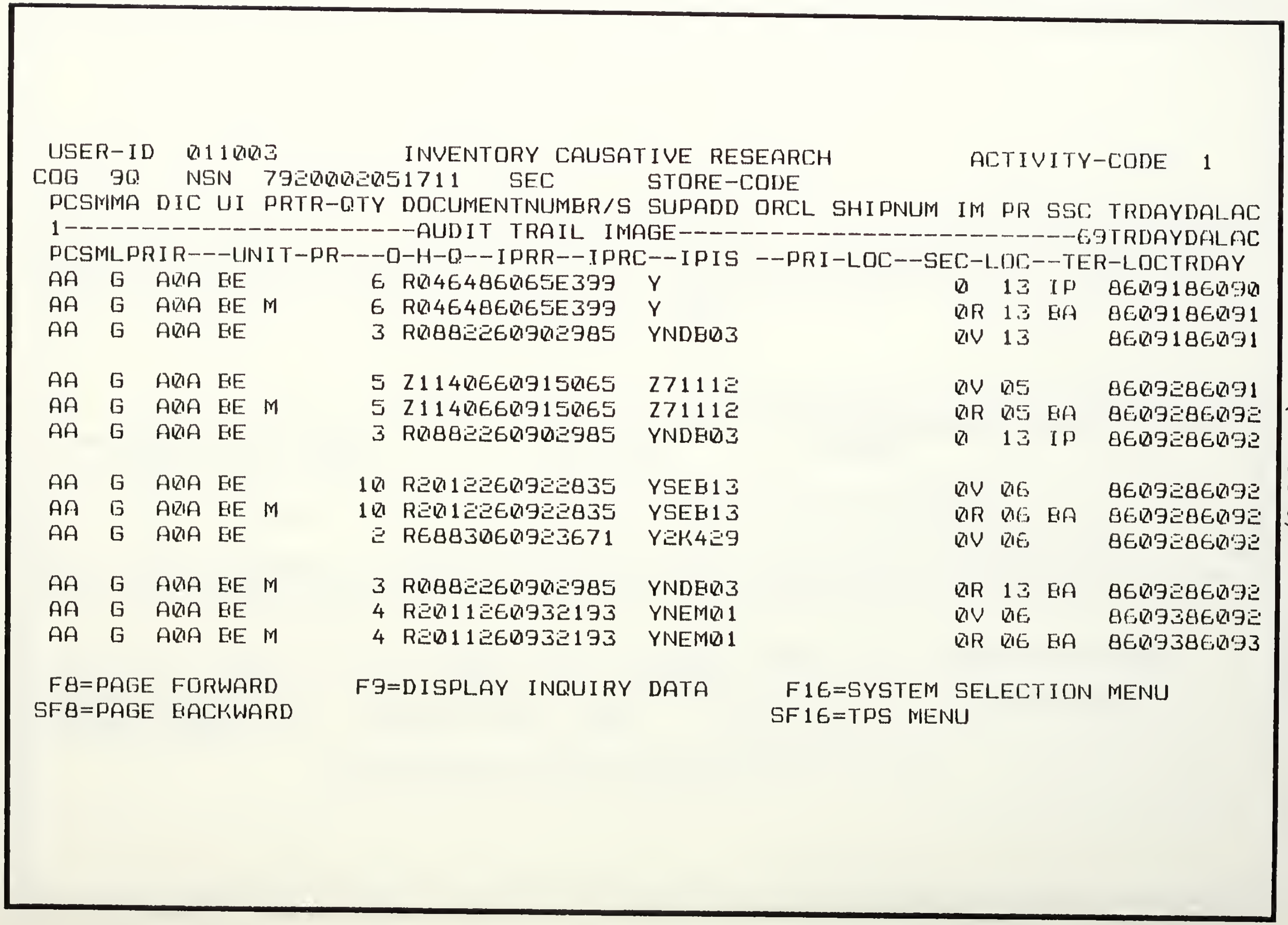
TLOD INQUIRY VIA ITEM FOR SPECIFIC DOCID



```
                 TLOD INQUIRY VIA ITEM FOR SPECIFIC DOCID

 NIIN    002051711     DOCUMENT ID   A0A       NEW DOCID    _    (Y-OR-BLANK)

 COG    __     FSC    ____      SMIC     __   PURPOSE CODE    _    CONDITION CODE   _


**************************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY     ***
*                                                                        *
*    IOR     _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED         *
*                                                                        *
*    ORDER CALL NUMBER    ____     FIR CODE   __    RI-FROM   ___        *
**************************************************************************




CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
==========================================================================
 F7 = FIND ITEM                SF9  = PRINT RESPONSE     F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH           F15 = CLEAR SCREEN      SF16 = TPS MENU
```

Screen 6

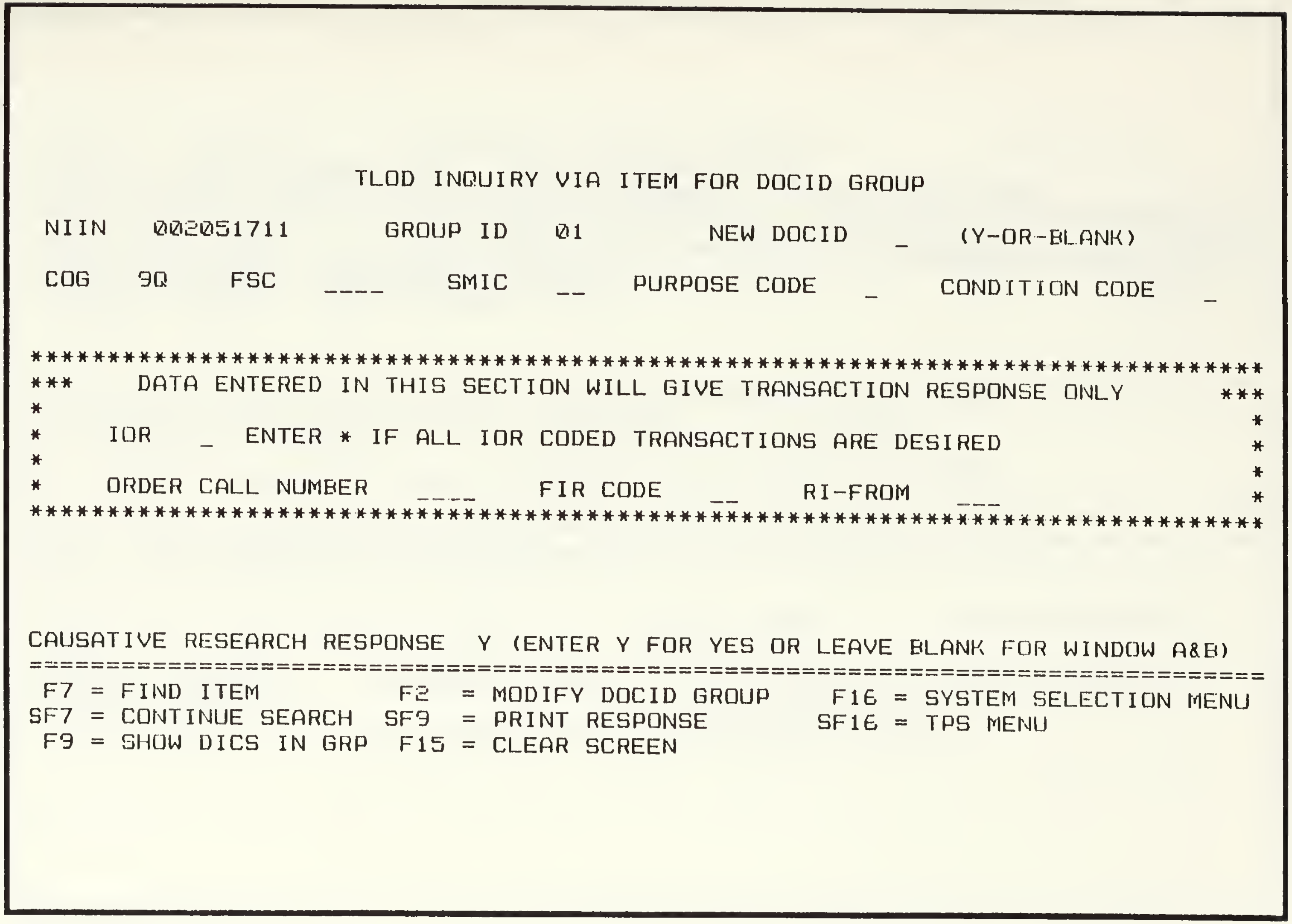
TLOD INQUIRY VIA ITEM FOR SPECIFIC DOCID
(RESULTS)



```
 USER-ID  011003         INVENTORY CAUSATIVE RESEARCH         ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711   SEC       STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1---------------------AUDIT TRAIL IMAGE-------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA   G   A0A BE            6 R046486065E399  Y                    0  13 IP  8609186090
 AA   G   A0A BE M          6 R046486065E399  Y                    0R 13 BA  8609186091
 AA   G   A0A BE            3 R088226090298 5 YNDB03               0V 13     8609186091

 AA   G   A0A BE            5 Z11406609150 65 Z71112               0V 05     8609286091
 AA   G   A0A BE M          5 Z11406609150 65 Z71112               0R 05 BA  8609286092
 AA   G   A0A BE            3 R088226090298 5 YNDB03               0  13 IP  8609286092

 AA   G   A0A BE           10 R201226092283 5 YSEB13               0V 06     8609286092
 AA   G   A0A BE M         10 R201226092283 5 YSEB13               0R 06 BA  8609286092
 AA   G   A0A BE            2 R688306092367 1 Y2K429               0V 06     8609286092

 AA   G   A0A BE M          3 R088226090298 5 YNDB03               0R 13 BA  8609286092
 AA   G   A0A BE            4 R201126093219 3 YNEM01               0V 06     8609386092
 AA   G   A0A BE M          4 R201126093219 3 YNEM01               0R 06 BA  8609386093

 F8=PAGE FORWARD     F9=DISPLAY INQUIRY DATA     F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                               SF16=TPS MENU
```

Screen 6A

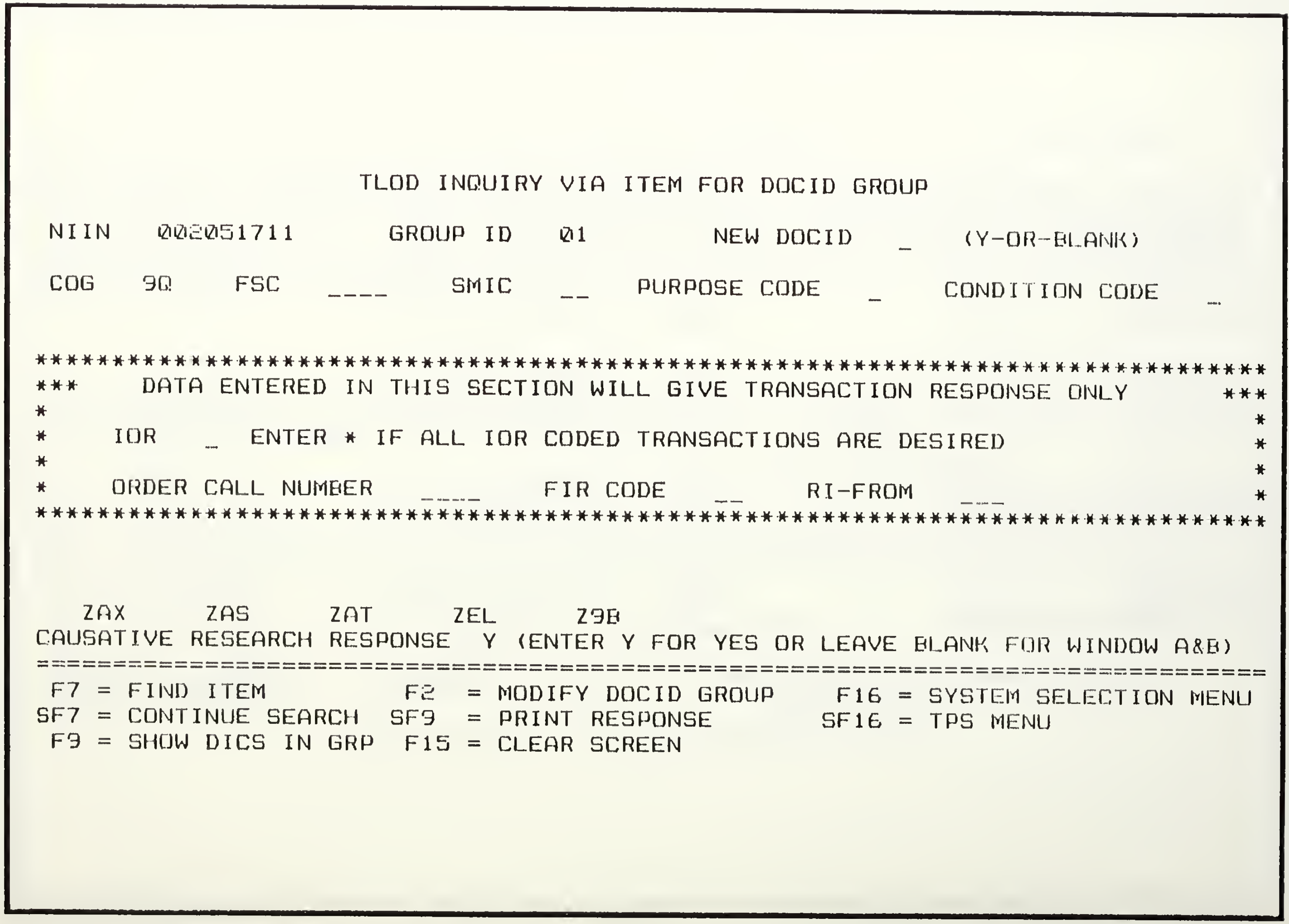
TLOD INQUIRY VIA ITEM FOR DOCID GROUP



```
                    TLOD INQUIRY VIA ITEM FOR DOCID GROUP

 NIIN   002051711      GROUP ID   01        NEW DOCID    _   (Y-OR-BLANK)

 COG   9Q    FSC   ____     SMIC    __   PURPOSE CODE    _   CONDITION CODE   _

*******************************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY      ***
*                                                                               *
*    IOR   _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED                 *
*                                                                               *
*    ORDER CALL NUMBER   ____     FIR CODE   __    RI-FROM  ___                 *
*******************************************************************************



CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
===============================================================================
 F7 = FIND ITEM          F2  = MODIFY DOCID GROUP    F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH   SF9  = PRINT RESPONSE       SF16 = TPS MENU
 F9 = SHOW DICS IN GRP  F15 = CLEAR SCREEN
```

Screen 7

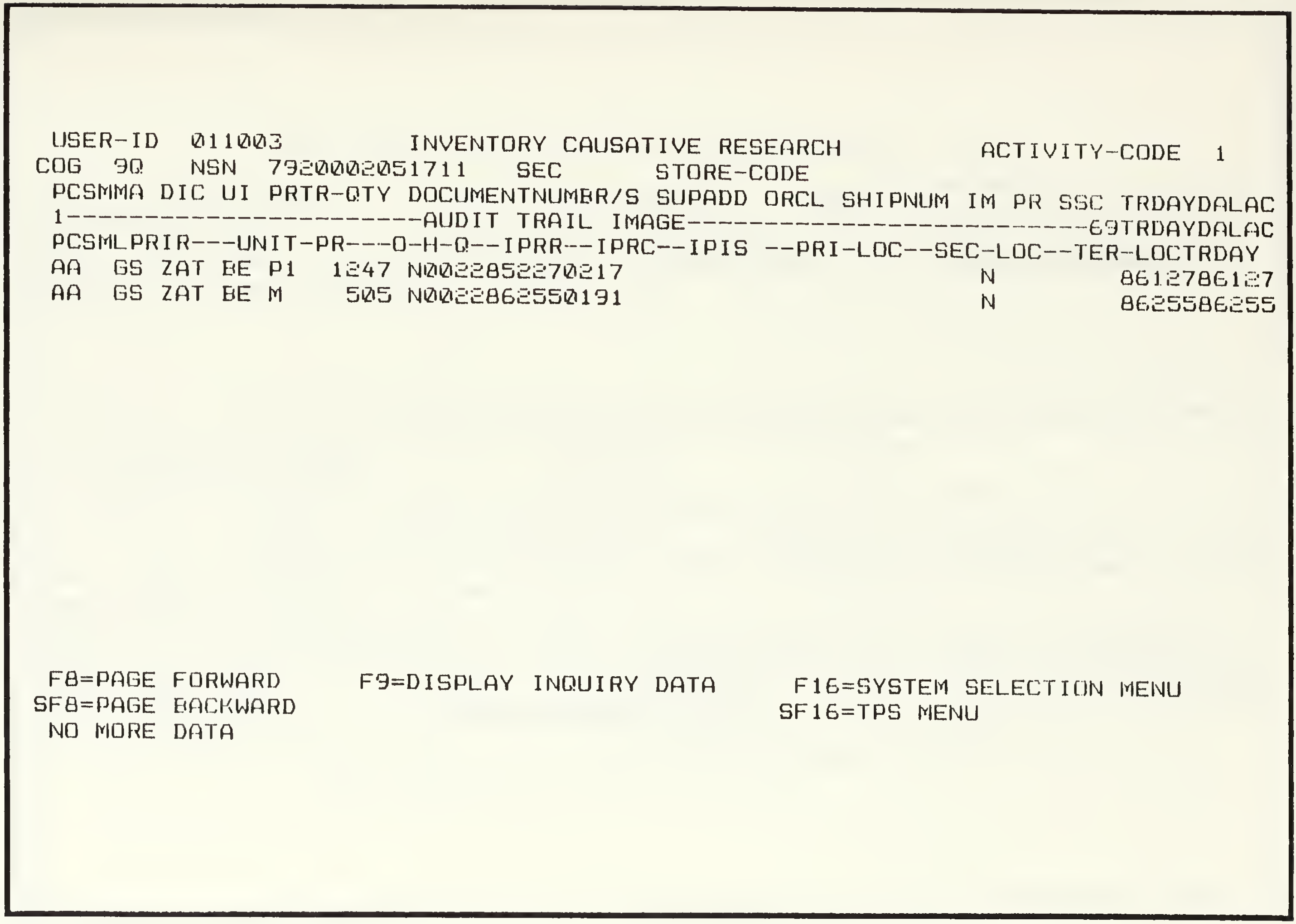
TLOD INQUIRY VIA ITEM FOR DOCID GROUP
(WITH SELECTED DOCID'S DISPLAYED)



```
                 TLOD INQUIRY VIA ITEM FOR DOCID GROUP

 NIIN   002051711      GROUP ID   01        NEW DOCID   _   (Y-OR-BLANK)

 COG   9Q    FSC   ____      SMIC    __   PURPOSE CODE    _    CONDITION CODE    _


********************************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY      ***
*                                                                              *
*    IOR    _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED               *
*                                                                              *
*    ORDER CALL NUMBER    _____     FIR CODE   __     RI-FROM    ___           *
********************************************************************************



   ZAX      ZAS      ZAT      ZEL      Z9B
CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
================================================================================
 F7 = FIND ITEM          F2  = MODIFY DOCID GROUP    F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH   SF9  = PRINT RESPONSE       SF16 = TPS MENU
 F9 = SHOW DICS IN GRP  F15 = CLEAR SCREEN
```

Screen 7A

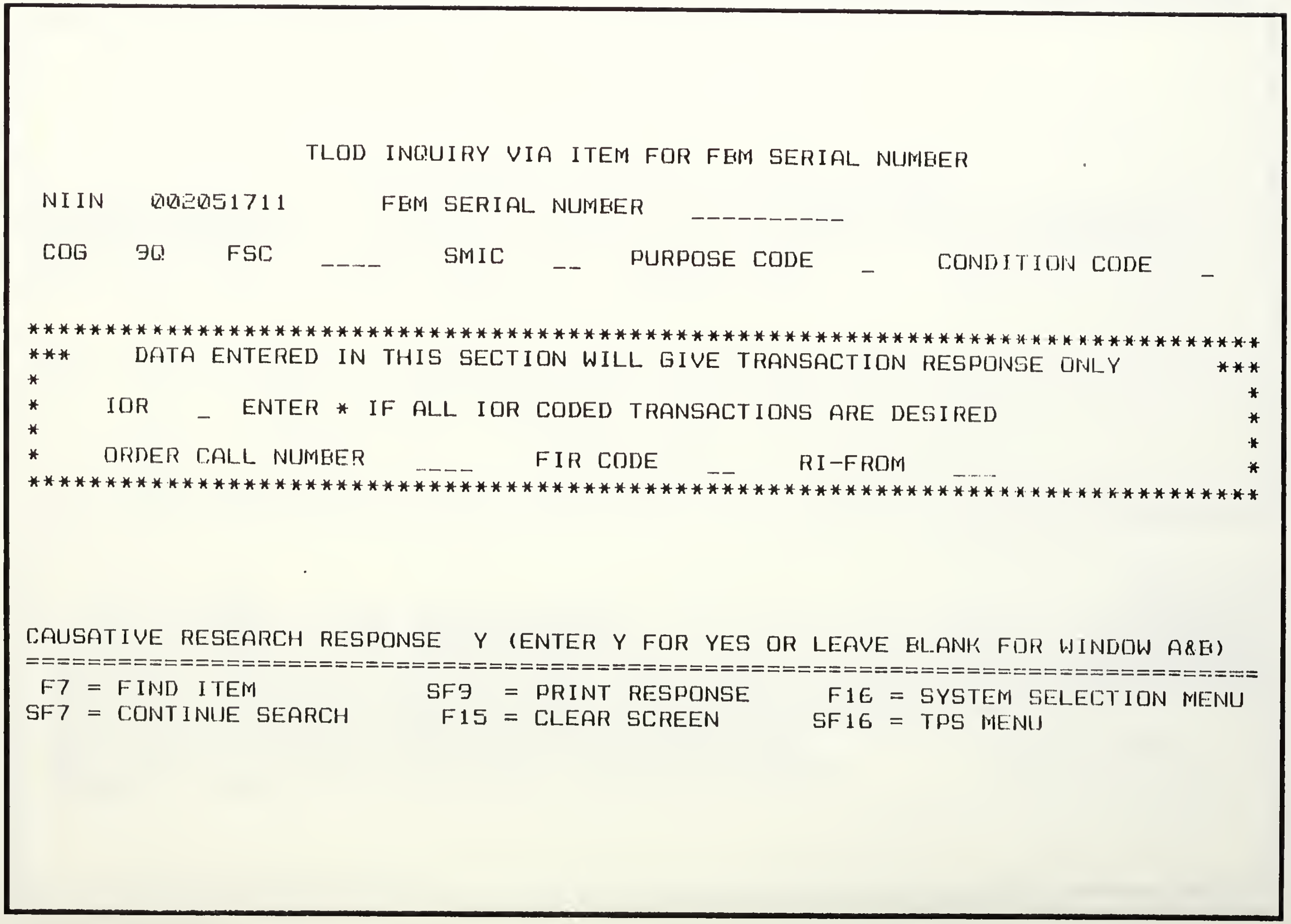
TLOD INQUIRY VIA ITEM FOR DOCID GROUP
(RESULTS)



```
USER-ID  011003        INVENTORY CAUSATIVE RESEARCH          ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711   SEC       STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1-----------------------AUDIT TRAIL IMAGE--------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA   GS ZAT BE P1   1247 N0022852270217                          N        8612786127
 AA   GS ZAT BE M     505 N0022862550191                          N        8625586255




 F8=PAGE FORWARD     F9=DISPLAY INQUIRY DATA     F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                               SF16=TPS MENU
 NO MORE DATA
```

Screen 7B

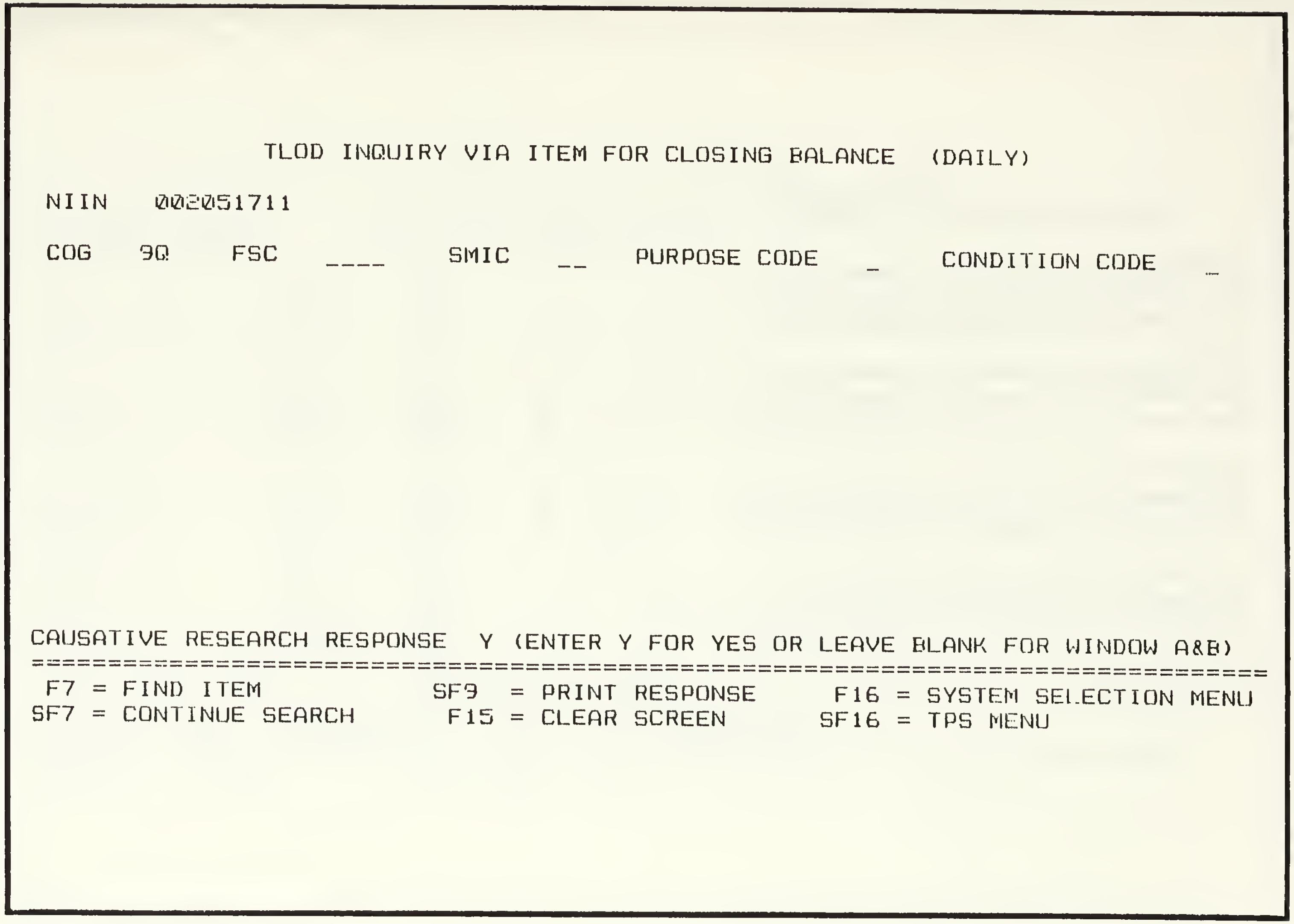
TLOD INQUIRY VIA ITEM FOR FBM SERIAL NUMBER



```
               TLOD INQUIRY VIA ITEM FOR FBM SERIAL NUMBER

NIIN   002051711       FBM SERIAL NUMBER  __________

COG   9Q    FSC   ____     SMIC   __    PURPOSE CODE   _    CONDITION CODE   _

*******************************************************************************
***    DATA ENTERED IN THIS SECTION WILL GIVE TRANSACTION RESPONSE ONLY     ***
*                                                                             *
*    IOR   _  ENTER * IF ALL IOR CODED TRANSACTIONS ARE DESIRED               *
*                                                                             *
*    ORDER CALL NUMBER   ____     FIR CODE   __     RI-FROM   ___             *
*******************************************************************************



CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
===============================================================================
 F7  = FIND ITEM             SF9  = PRINT RESPONSE      F16  = SYSTEM SELECTION MENU
SF7  = CONTINUE SEARCH        F15 = CLEAR SCREEN       SF16  = TPS MENU
```

Screen 8

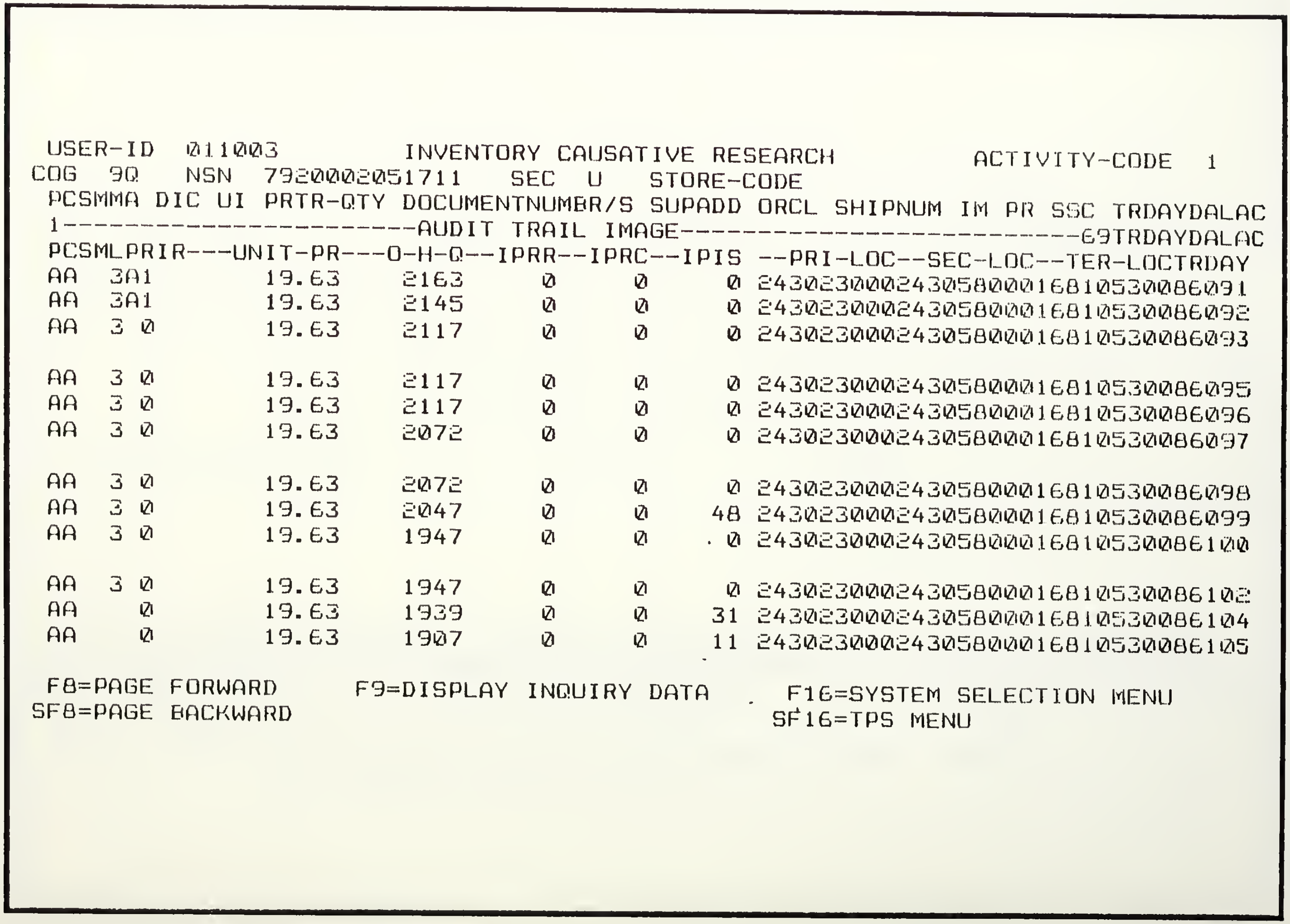
TLOD INQUIRY VIA ITEM FOR CLOSING BALANCE (DAILY)



```
               TLOD INQUIRY VIA ITEM FOR CLOSING BALANCE   (DAILY)

 NIIN   002051711

 COG   9Q     FSC   ____     SMIC   __    PURPOSE CODE   _    CONDITION CODE   _








CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
================================================================================
 F7 = FIND ITEM             SF9  = PRINT RESPONSE      F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH        F15 = CLEAR SCREEN       SF16 = TPS MENU
```

Screen 9

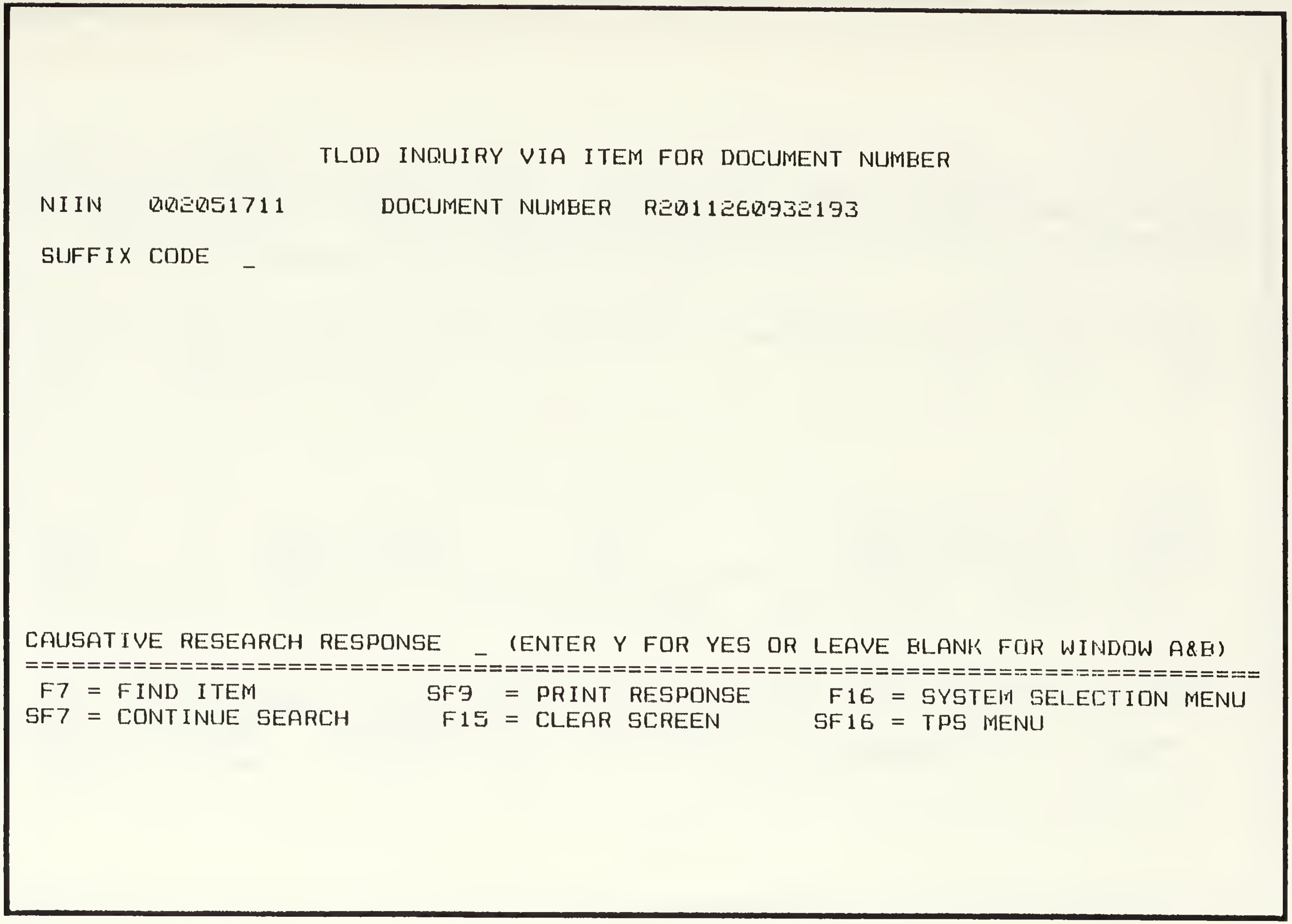
TLOD INQUIRY VIA ITEM FOR CLOSING BALANCE (DAILY)
(RESULTS)



```
 USER-ID  011003         INVENTORY CAUSATIVE RESEARCH          ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711    SEC  U   STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1-----------------------AUDIT TRAIL IMAGE--------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA   3A1        19.63     2163      0      0      0 24302300024305800016810530086091
 AA   3A1        19.63     2145      0      0      0 24302300024305800016810530086092
 AA   3 0        19.63     2117      0      0      0 24302300024305800016810530086093

 AA   3 0        19.63     2117      0      0      0 24302300024305800016810530086095
 AA   3 0        19.63     2117      0      0      0 24302300024305800016810530086096
 AA   3 0        19.63     2072      0      0      0 24302300024305800016810530086097

 AA   3 0        19.63     2072      0      0      0 24302300024305800016810530086098
 AA   3 0        19.63     2047      0      0     48 24302300024305800016810530086099
 AA   3 0        19.63     1947      0      0      0 24302300024305800016810530086100

 AA   3 0        19.63     1947      0      0      0 24302300024305800016810530086102
 AA     0        19.63     1939      0      0     31 24302300024305800016810530086104
 AA     0        19.63     1907      0      0     11 24302300024305800016810530086105

 F8=PAGE FORWARD      F9=DISPLAY INQUIRY DATA       F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                                  SF16=TPS MENU
```

Screen 9A

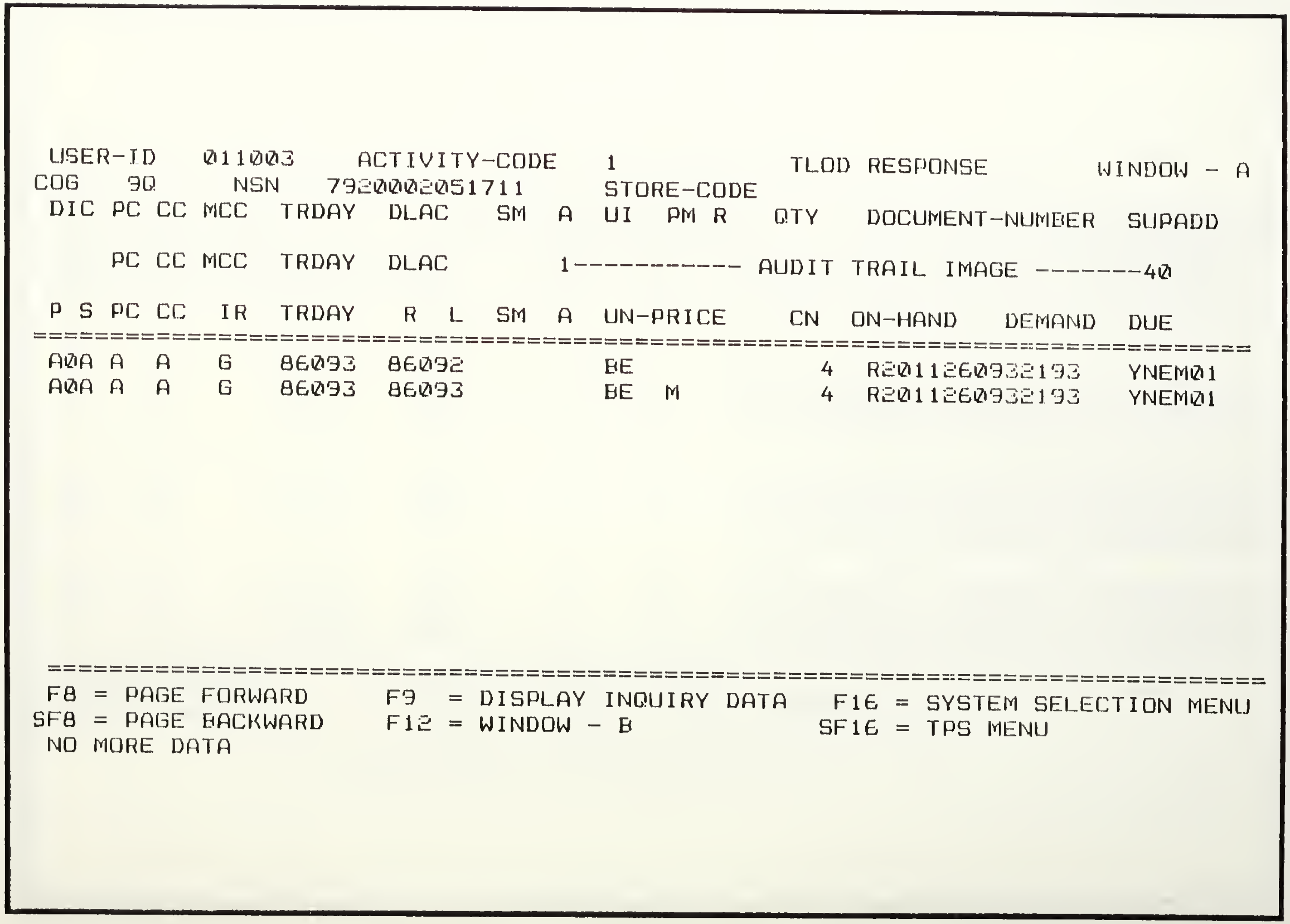
TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER



```
                    TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER
 NIIN   002051711      DOCUMENT NUMBER  R2011260932193

 SUFFIX CODE  _








CAUSATIVE RESEARCH RESPONSE  _ (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
==============================================================================
 F7 = FIND ITEM              SF9  = PRINT RESPONSE      F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH         F15 = CLEAR SCREEN       SF16 = TPS MENU
```

Screen 10

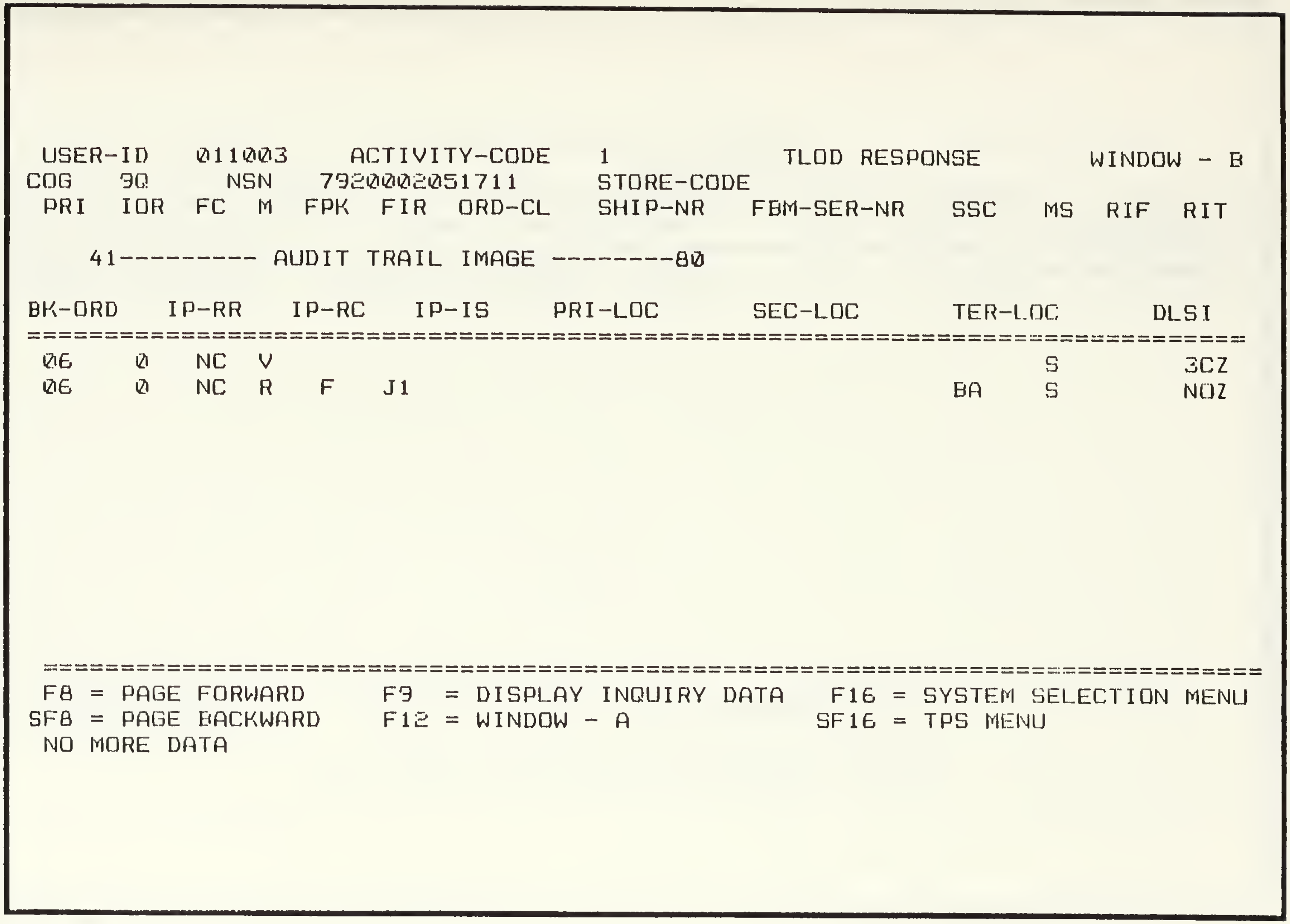
TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER
(WINDOW A RESULTS)



```
USER-ID    011003     ACTIVITY-CODE    1          TLOD RESPONSE        WINDOW - A
COG    9Q      NSN    7920002051711      STORE-CODE
DIC PC CC MCC   TRDAY   DLAC    SM   A   UI   PM R    QTY    DOCUMENT-NUMBER   SUPADD

    PC CC MCC   TRDAY   DLAC        1------------ AUDIT TRAIL IMAGE -------40

P S PC CC   IR   TRDAY    R  L   SM   A   UN-PRICE     CN   ON-HAND    DEMAND   DUE
==================================================================================
A0A A   A    G   86093  86092             BE                4   R2011260932193    YNEM01
A0A A   A    G   86093  86093             BE   M            4   R2011260932193    YNEM01










==================================================================================
F8  = PAGE FORWARD      F9  = DISPLAY INQUIRY DATA   F16  = SYSTEM SELECTION MENU
SF8 = PAGE BACKWARD     F12 = WINDOW - B             SF16 = TPS MENU
NO MORE DATA
```

Screen 10A

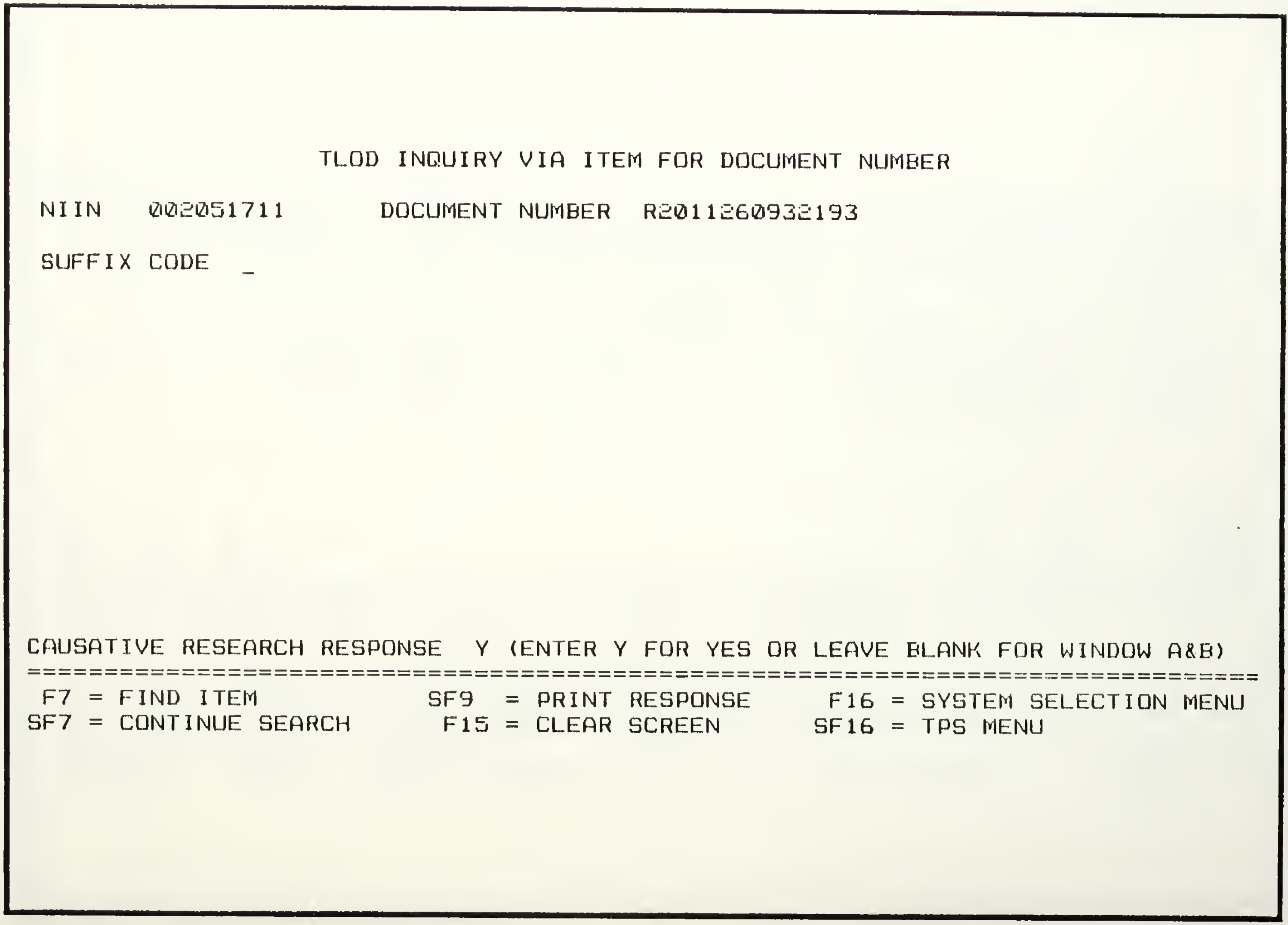
TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER
(WINDOW B RESULTS)



```
 USER-ID   011003    ACTIVITY-CODE   1           TLOD RESPONSE      WINDOW - B
COG   9Q     NSN   7920002051711     STORE-CODE
 PRI  IOR  FC  M  FPK  FIR  ORD-CL   SHIP-NR   FBM-SER-NR   SSC   MS   RIF  RIT

    41--------- AUDIT TRAIL IMAGE ---------80

BK-ORD   IP-RR   IP-RC   IP-IS    PRI-LOC      SEC-LOC      TER-LOC      DLSI
================================================================================
 06     0     NC  V                                                 S       3CZ
 06     0     NC  R    F    J1                                BA    S       NOZ









 ================================================================================
 F8  = PAGE FORWARD      F9  = DISPLAY INQUIRY DATA    F16 = SYSTEM SELECTION MENU
SF8  = PAGE BACKWARD     F12 = WINDOW - A             SF16 = TPS MENU
 NO MORE DATA
```

Screen 10B

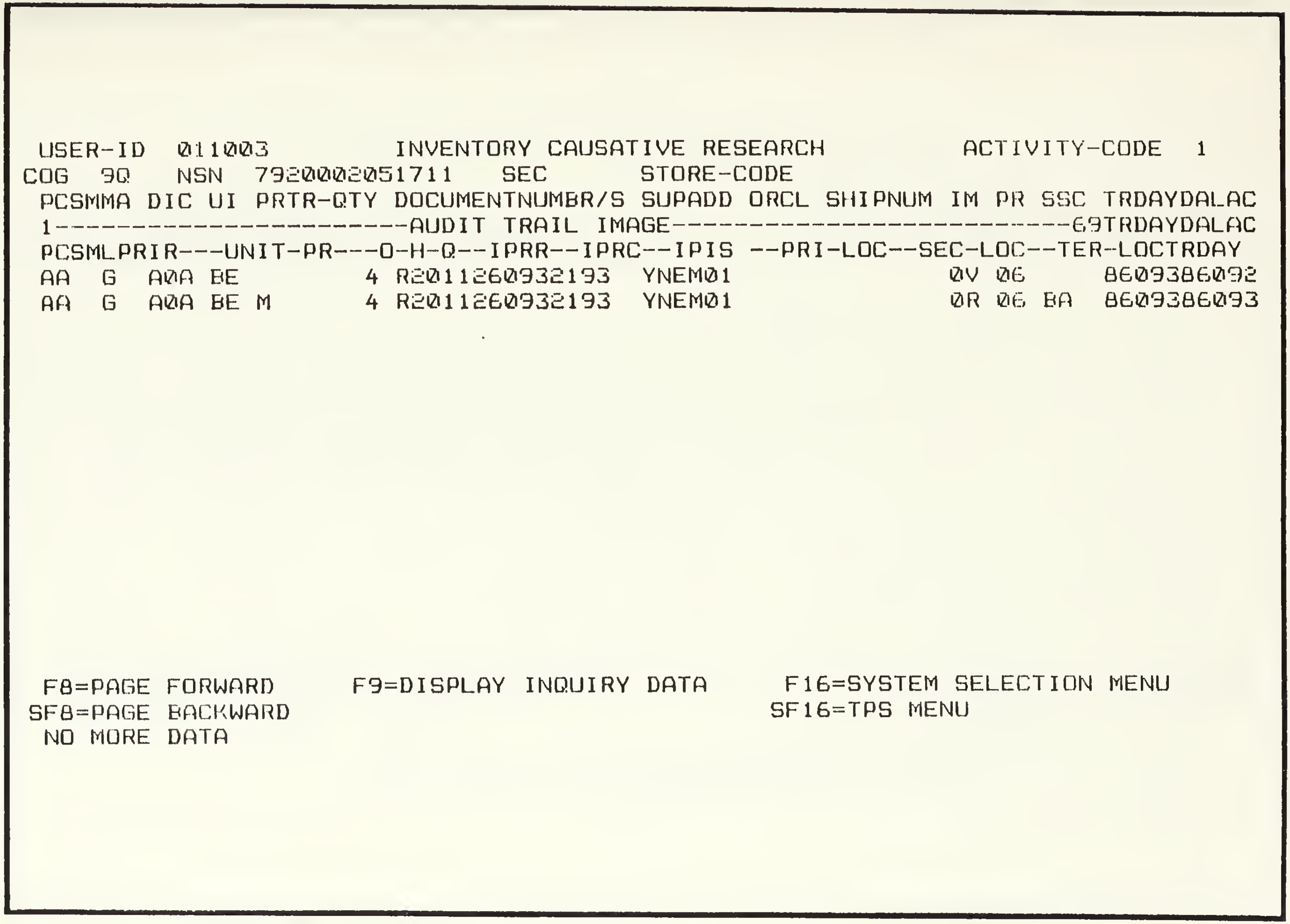
TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER
(SELECTING "Y" FOR CAUSATIVE RESEARCH)



```
                    TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER

 NIIN   002051711        DOCUMENT NUMBER  R2011260932193

 SUFFIX CODE  _













CAUSATIVE RESEARCH RESPONSE  Y (ENTER Y FOR YES OR LEAVE BLANK FOR WINDOW A&B)
================================================================================
 F7 = FIND ITEM           SF9  = PRINT RESPONSE     F16 = SYSTEM SELECTION MENU
SF7 = CONTINUE SEARCH      F15 = CLEAR SCREEN      SF16 = TPS MENU
```

Screen 11

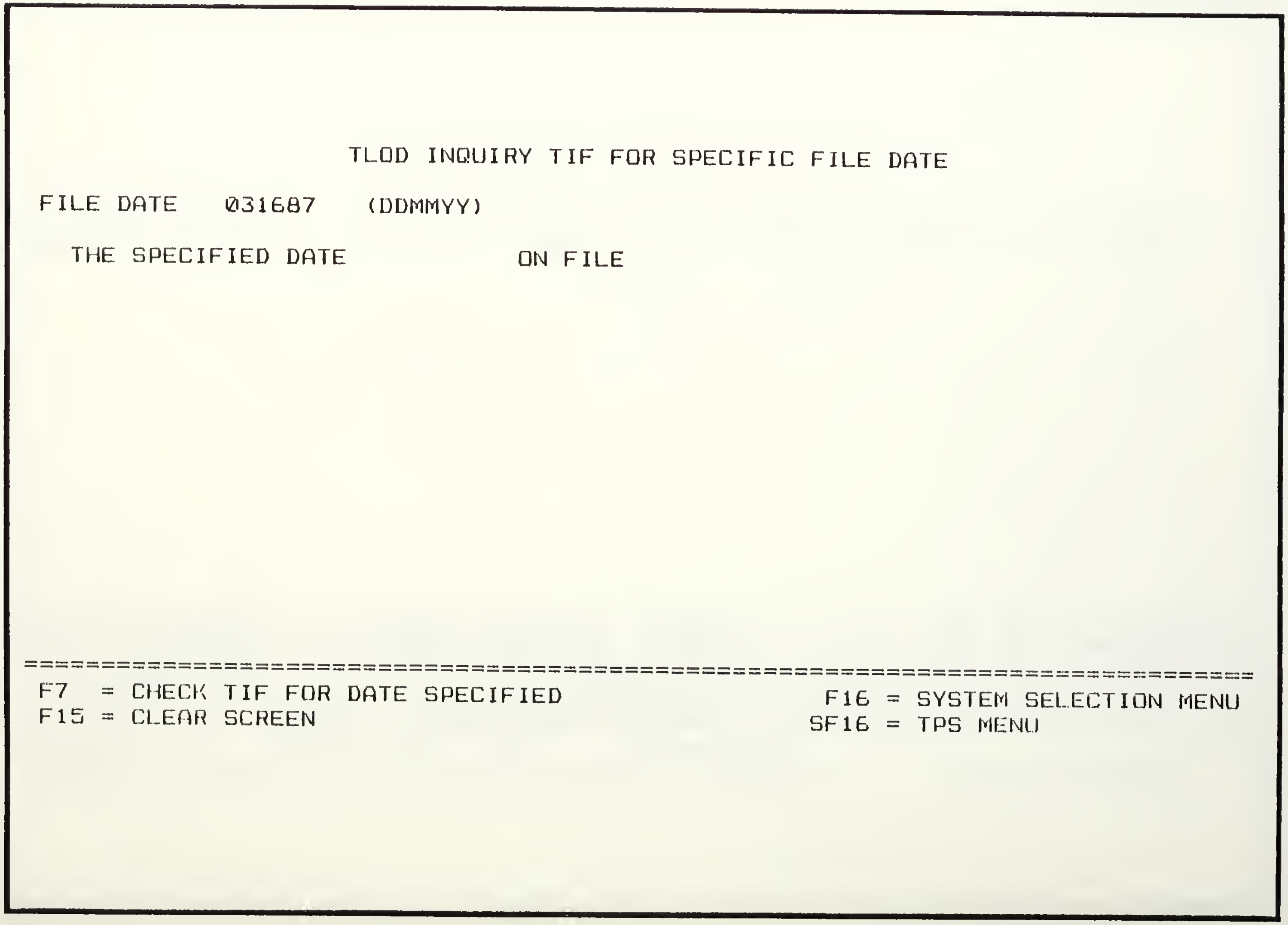
TLOD INQUIRY VIA ITEM FOR DOCUMENT NUMBER
(SHORT FORM RESULTS)



```
 USER-ID  011003        INVENTORY CAUSATIVE RESEARCH         ACTIVITY-CODE  1
COG  9Q   NSN  7920002051711   SEC      STORE-CODE
 PCSMMA DIC UI PRTR-QTY DOCUMENTNUMBR/S SUPADD ORCL SHIPNUM IM PR SSC TRDAYDALAC
 1-----------------------AUDIT TRAIL IMAGE--------------------------69TRDAYDALAC
 PCSMLPRIR---UNIT-PR---O-H-Q--IPRR--IPRC--IPIS --PRI-LOC--SEC-LOC--TER-LOCTRDAY
 AA  G  A0A BE        4 R2011260932193  YNEM01              0V 06     8609386092
 AA  G  A0A BE M      4 R2011260932193  YNEM01              0R 06 BA  8609386093




 F8=PAGE FORWARD     F9=DISPLAY INQUIRY DATA     F16=SYSTEM SELECTION MENU
SF8=PAGE BACKWARD                               SF16=TPS MENU
 NO MORE DATA
```

Screen 11A

TLOD INQUIRY TIF FOR SPECIFIC FILE DATE

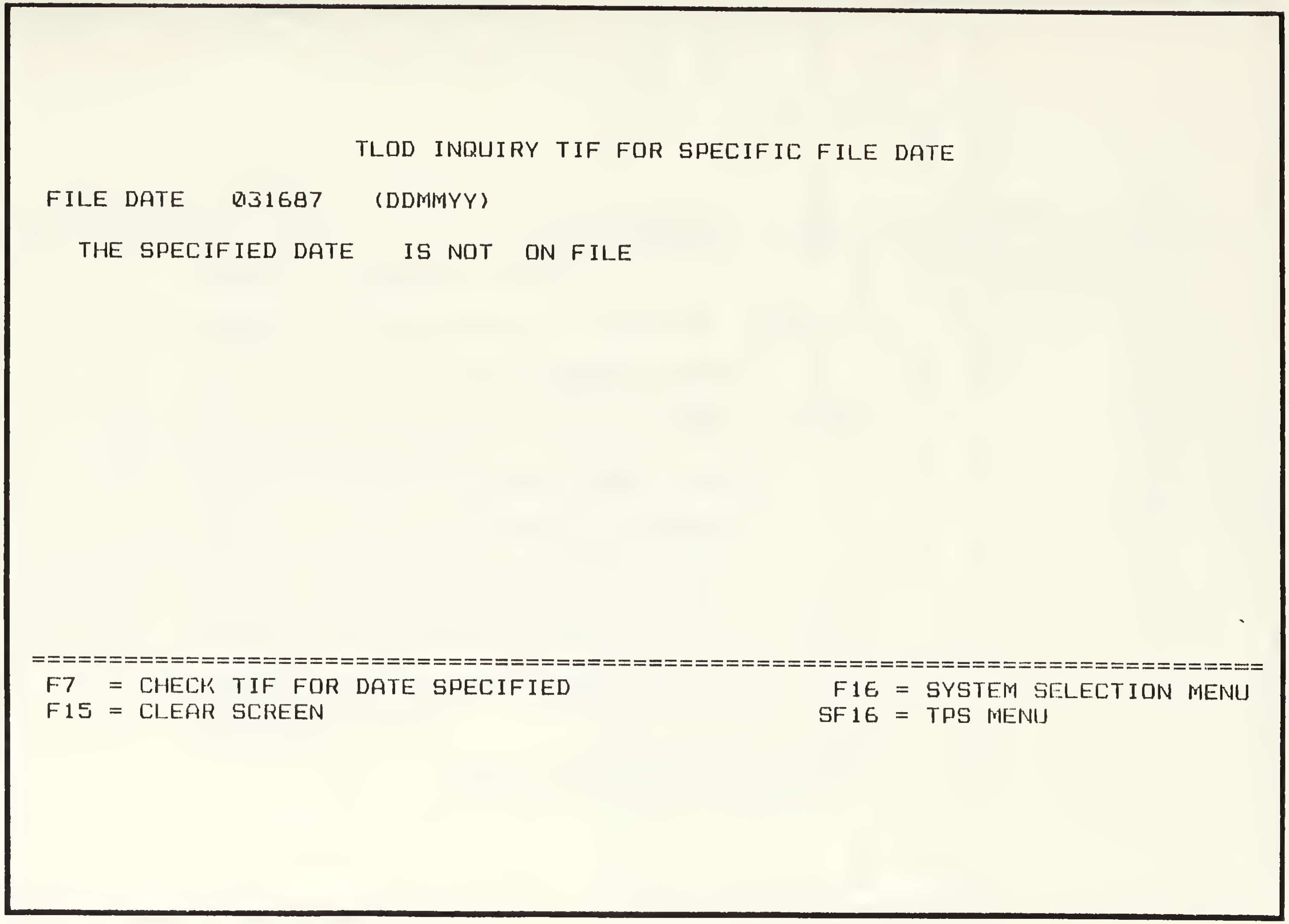


```
                     TLOD INQUIRY TIF FOR SPECIFIC FILE DATE
 FILE DATE   031687   (DDMMYY)

   THE SPECIFIED DATE           ON FILE











================================================================================
 F7   = CHECK TIF FOR DATE SPECIFIED                 F16 = SYSTEM SELECTION MENU
 F15 = CLEAR SCREEN                                 SF16 = TPS MENU
```

Screen 12

TLOD INQUIRY TIF FOR SPECIFIC FILE DATE

(RESULTS)

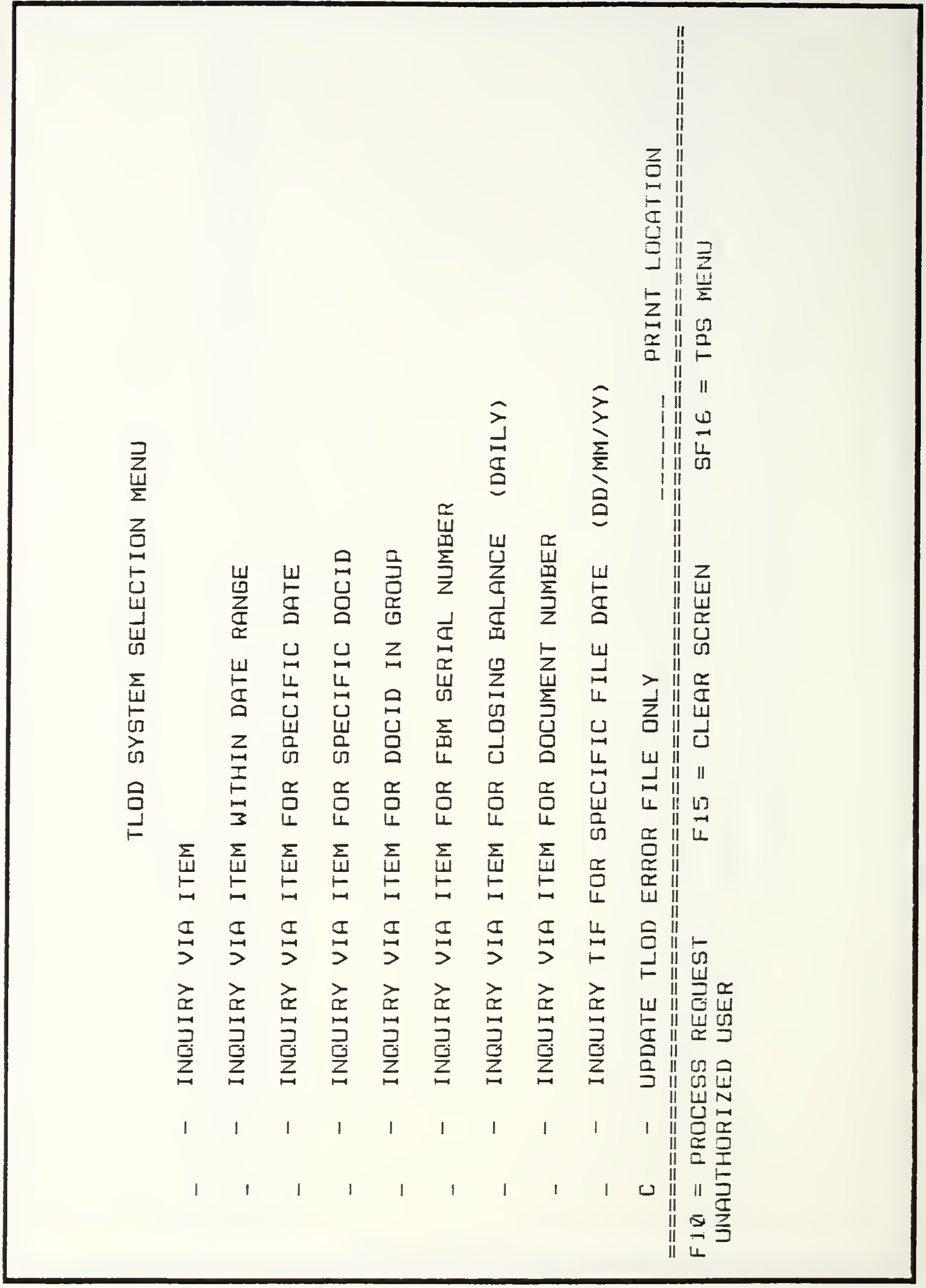


```
                 TLOD INQUIRY TIF FOR SPECIFIC FILE DATE
FILE DATE   031687   (DDMMYY)
  THE SPECIFIED DATE   IS NOT  ON FILE










===========================================================================
F7   = CHECK TIF FOR DATE SPECIFIED                  F16 = SYSTEM SELECTION MENU
F15 = CLEAR SCREEN                                   SF16 = TPS MENU
```

Screen 12A

TLOD SYSTEM SELECTION MENU

(REFLECTS ACCESS TO LAST MENU SELECTION AS NOT AUTHORIZED)



```
              TLOD SYSTEM SELECTION MENU

 _  -  INQUIRY VIA ITEM
 _  -  INQUIRY VIA ITEM WITHIN DATE RANGE
 _  -  INQUIRY VIA ITEM FOR SPECIFIC DATE
 _  -  INQUIRY VIA ITEM FOR SPECIFIC DOCID
 _  -  INQUIRY VIA ITEM FOR DOCID IN GROUP
 _  -  INQUIRY VIA ITEM FOR FBM SERIAL NUMBER
 _  -  INQUIRY VIA ITEM FOR CLOSING BALANCE  (DAILY)
 _  -  INQUIRY VIA ITEM FOR DOCUMENT NUMBER
 _  -  INQUIRY TIF FOR SPECIFIC FILE DATE  (DD/MM/YY)
 C  -  UPDATE TLOD ERROR FILE ONLY            ________  PRINT LOCATION
==============================================================================
F10 = PROCESS REQUEST       F15 = CLEAR SCREEN       SF16 = TPS MENU
UNAUTHORIZED USER
```

Screen 13

APPENDIX B

SCREEN DUMPS FROM THE NEW TLOCD SYSTEM

This appendix contains the new TLOCD screen dumps and shows the initial screens/menus, as well as sample results from each inquiry. It also presents the TLOCD retrieval process in hierarchy format as Figure 15, and the directory listing from the actual TLOCD disc, or dataplate. The directory reflects 359.5 Mbytes of usage for data, and 35.8 Mbytes of usage for indexing, for a total of 395.3 Mbytes.

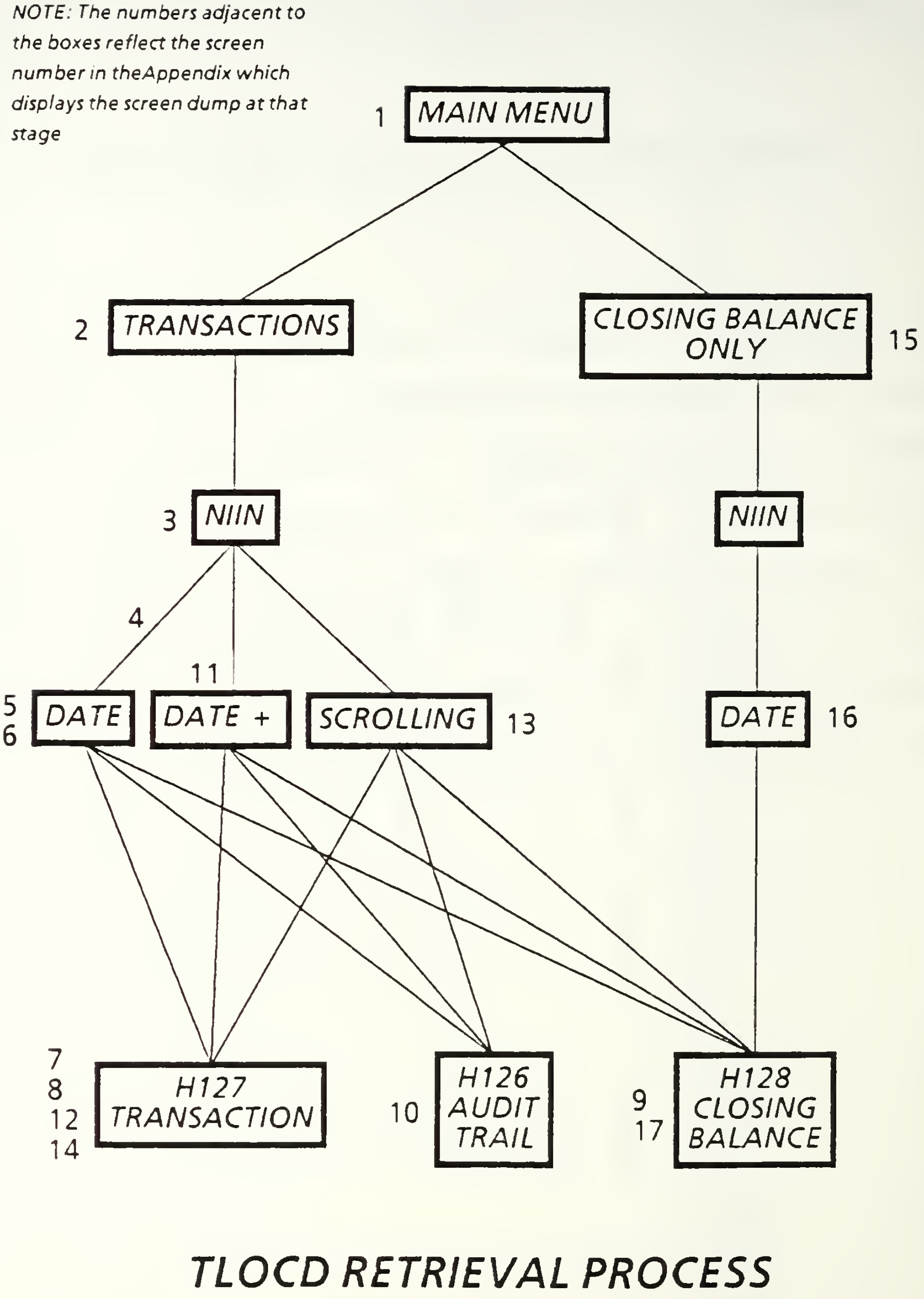


Figure 15. TLOCD Retrieval Process

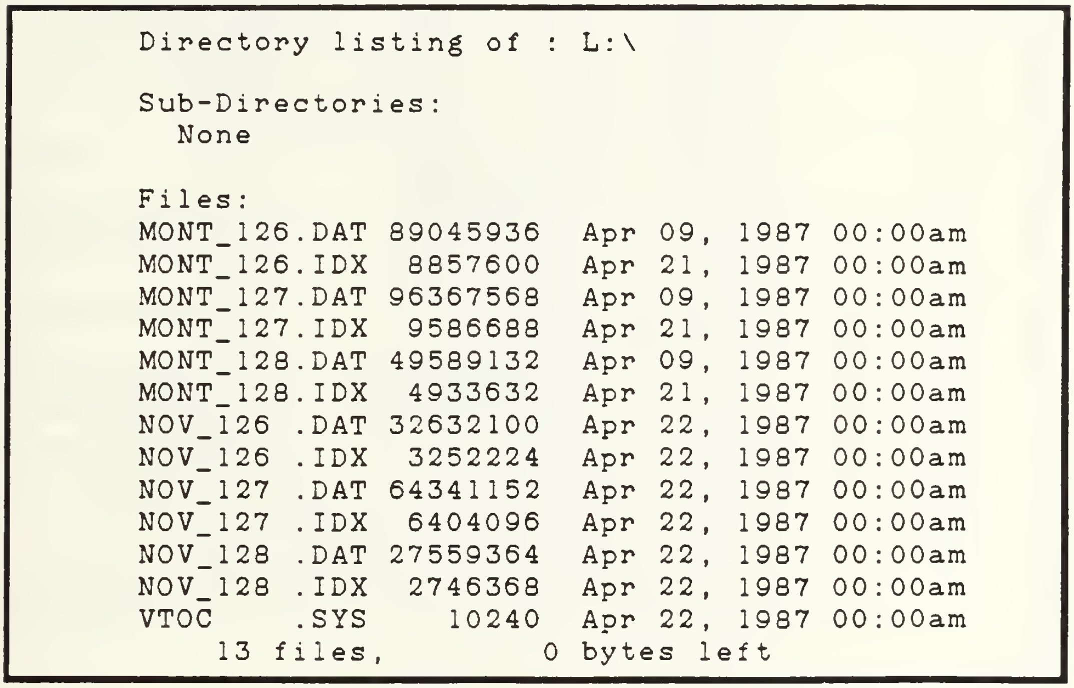
TRANSACTION LEDGER ON COMPACT DISC

(TLOCD)

Directory Listing of the "L" Drive
(Optical Disc Drive)

359.5 MB of Data
35.8 MB of Indexing
395.3 MB Total

(Remaining space on the 540 MB disc = 114.7 MB)



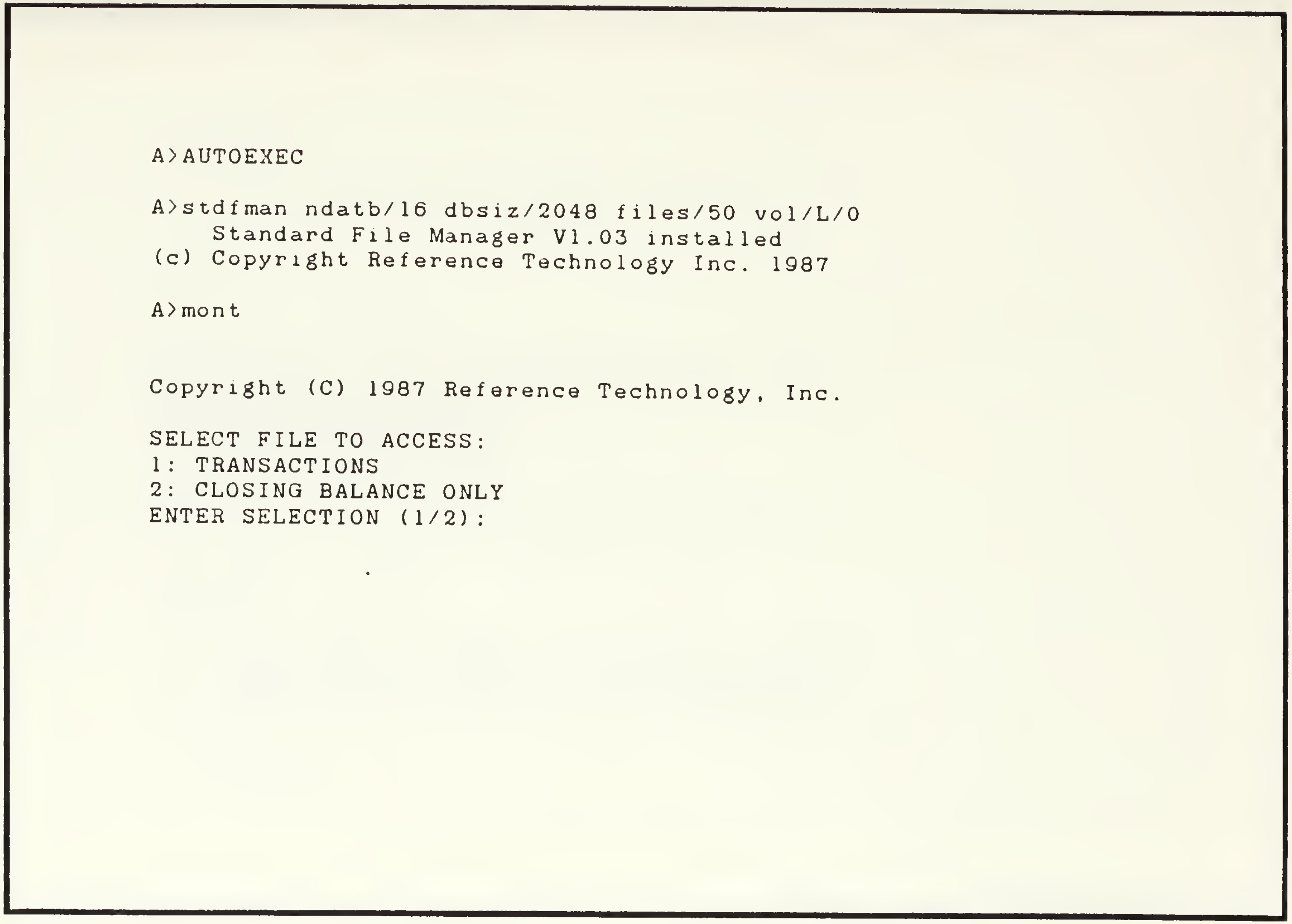
```
Directory listing of : L:\

Sub-Directories:
  None

Files:
MONT_126.DAT 89045936  Apr 09, 1987 00:00am
MONT_126.IDX  8857600  Apr 21, 1987 00:00am
MONT_127.DAT 96367568  Apr 09, 1987 00:00am
MONT_127.IDX  9586688  Apr 21, 1987 00:00am
MONT_128.DAT 49589132  Apr 09, 1987 00:00am
MONT_128.IDX  4933632  Apr 21, 1987 00:00am
NOV_126 .DAT 32632100  Apr 22, 1987 00:00am
NOV_126 .IDX  3252224  Apr 22, 1987 00:00am
NOV_127 .DAT 64341152  Apr 22, 1987 00:00am
NOV_127 .IDX  6404096  Apr 22, 1987 00:00am
NOV_128 .DAT 27559364  Apr 22, 1987 00:00am
NOV_128 .IDX  2746368  Apr 22, 1987 00:00am
VTOC    .SYS    10240  Apr 22, 1987 00:00am
    13 files,        0 bytes left
```

Figure 16. TLOCD Directory Listing

Listing Of Screen Dumps In Appendix B

Screen	Title
1	TLOCD Main Menu & Copyright Statement
2	TLOCD Main Menu With Transaction Selected
3	TLOCD Transaction Selected and NIIN Entered
4	TLOCD Transaction With Date Search Menu
5	TLOCD Transaction With Date Only Selected
6	TLOCD Transaction With Date Entered
7	TLOCD Transaction With Date Entered (H127 Transaction Results)
8	TLOCD Transaction With Date Entered (H127 Transaction Results (Scrolling))
9	TLOCD Transaction With Date Entered (H128 Closing Balance Results)
10	TLOCD Transaction With Date Entered (H126 Audit Trail Results)
11	TLOCD Transaction With Date Or Later Selected & Entered
12	TLOCD Transaction With Date Or Later Selected & Entered (H127 Transaction Results)
13	TLOCD Transaction With Any Date/Scroll Selected
14	TLOCD Transaction With Any Date/Scroll Selected (H127 Transaction Results)
15	TLOCD Main Menu With Closing Balance Only Selected
16	TLOCD Main Menu With Closing Balance Only Selected (And Date Entered)
17	TLOCD Main Menu With Closing Balance Only Selected (And Date Entered) (H128 Closing Balance Results)

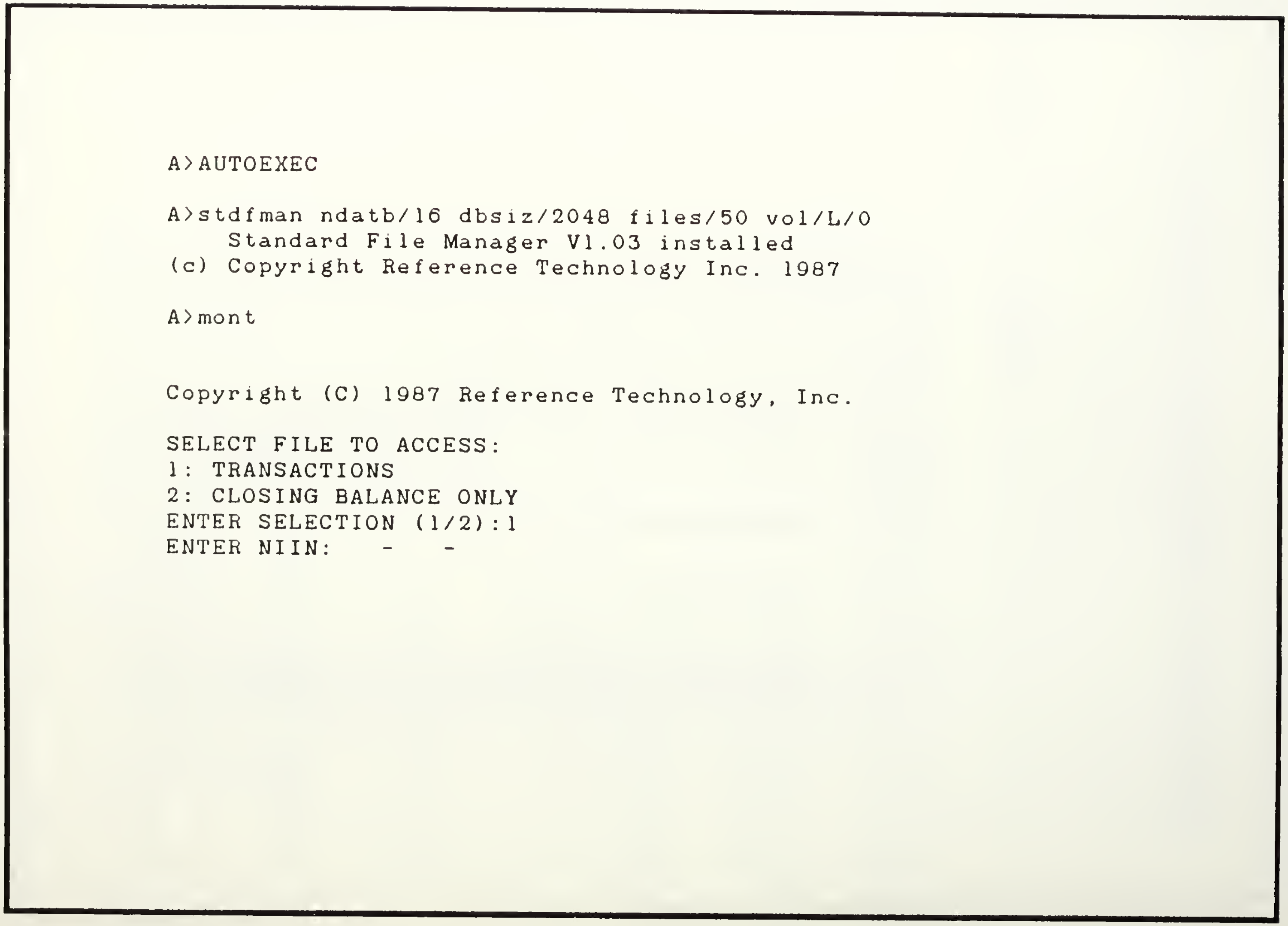
TLOCD MAIN MENU & COPYRIGHT STATEMENT



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):
```

Screen 1

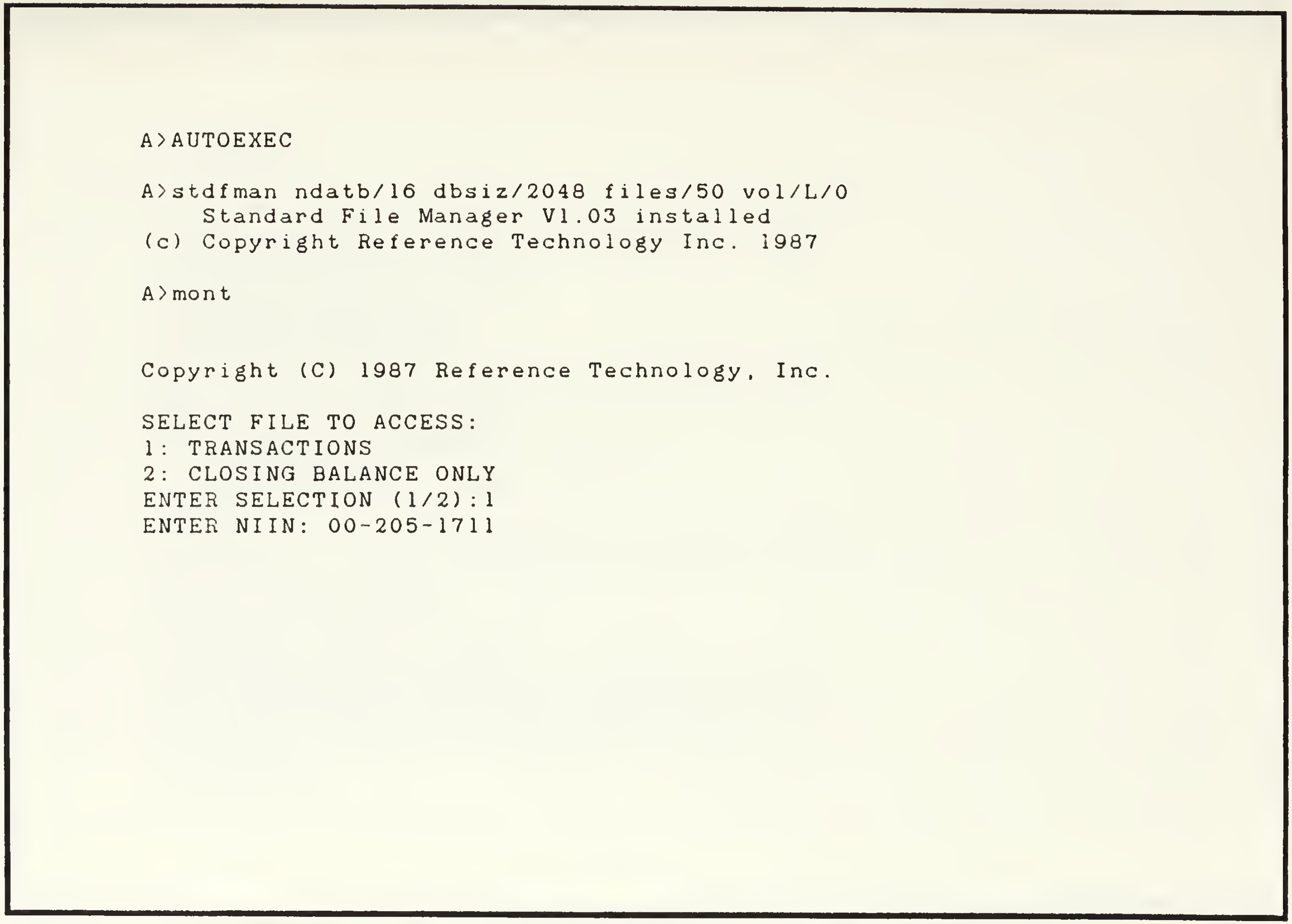
TLOCD MAIN MENU WITH TRANSACTION SELECTED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN:    -    -
```

Screen 2

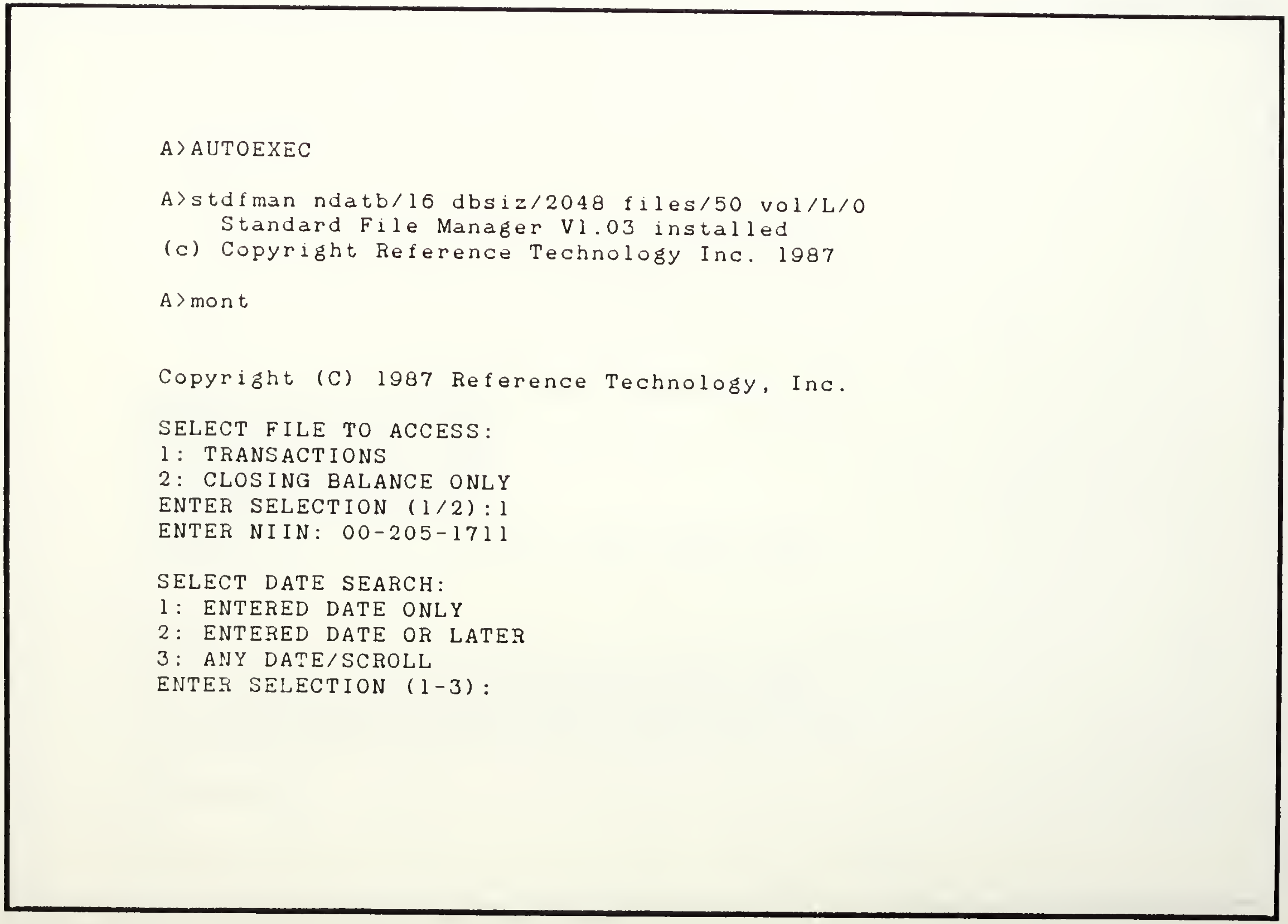
TLOCD TRANSACTION SELECTED AND NIIN ENTERED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN: 00-205-1711
```

Screen 3

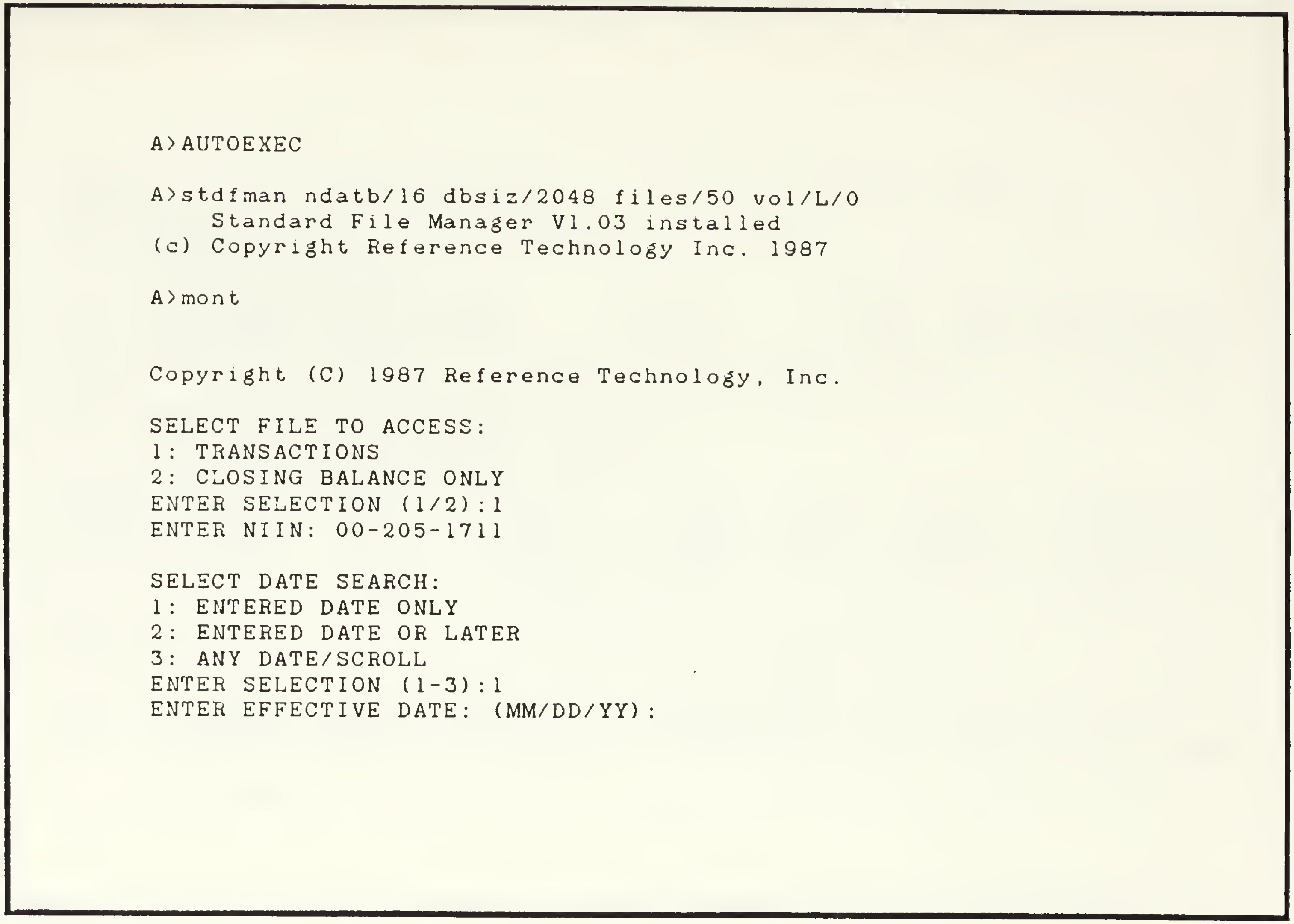
TLOCD TRANSACTION WITH DATE SEARCH MENU



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN: 00-205-1711

SELECT DATE SEARCH:
1: ENTERED DATE ONLY
2: ENTERED DATE OR LATER
3: ANY DATE/SCROLL
ENTER SELECTION (1-3):
```

Screen 4

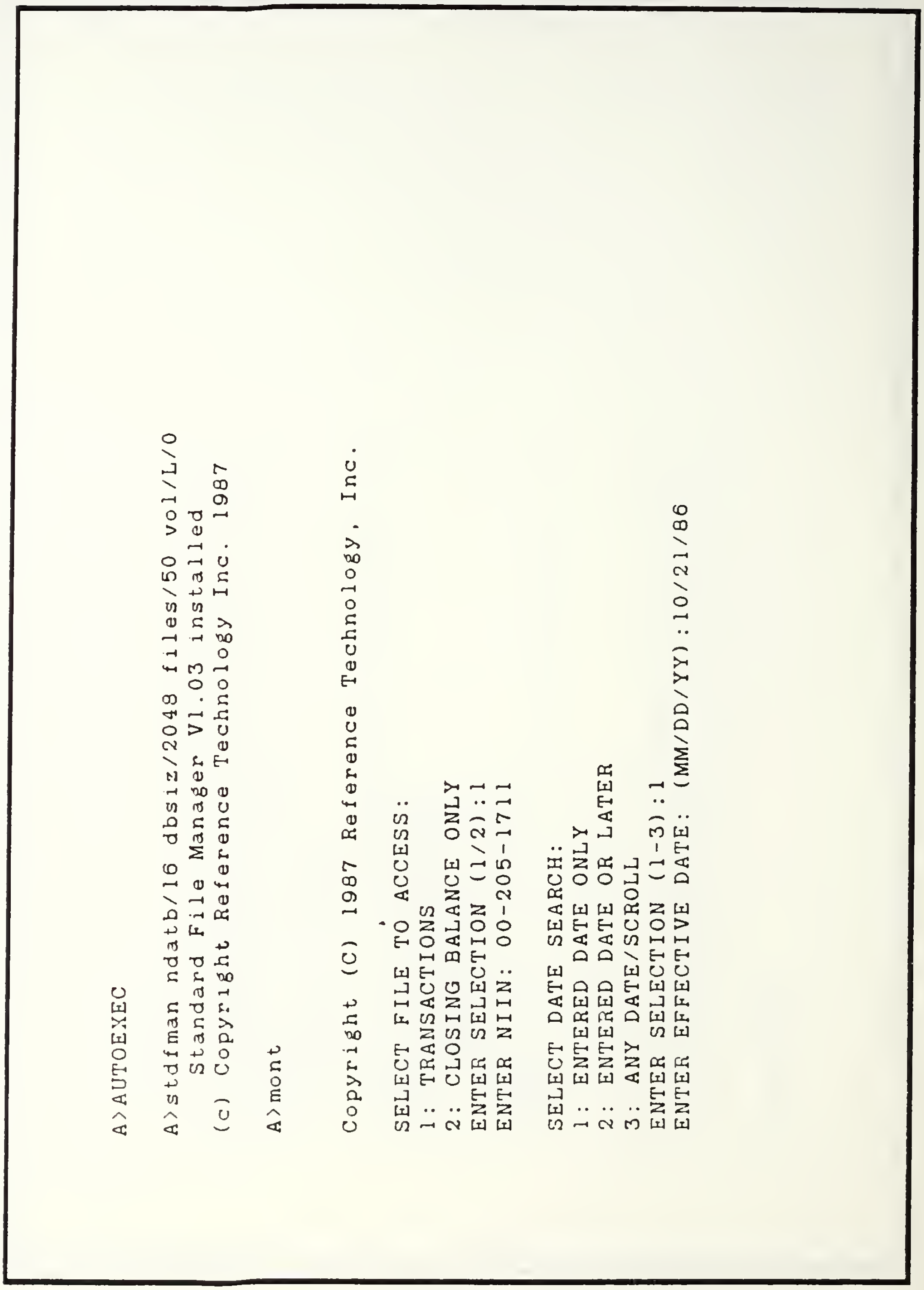
TLOCD TRANSACTION WITH DATE ONLY SELECTED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN: 00-205-1711

SELECT DATE SEARCH:
1: ENTERED DATE ONLY
2: ENTERED DATE OR LATER
3: ANY DATE/SCROLL
ENTER SELECTION (1-3):1
ENTER EFFECTIVE DATE: (MM/DD/YY):
```

Screen 5

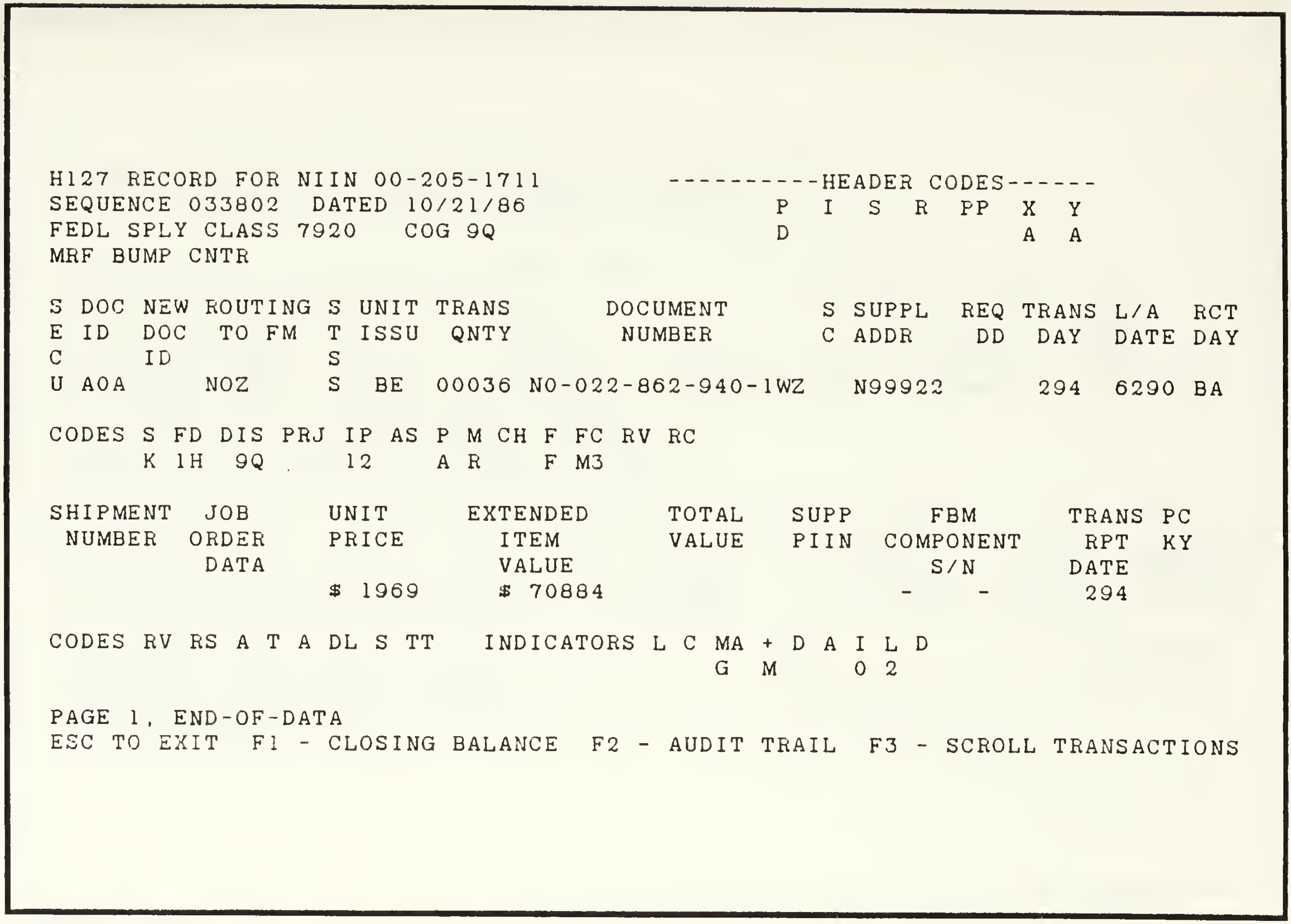
TLOCD TRANSACTION WITH DATE ENTERED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont

Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN: 00-205-1711

SELECT DATE SEARCH:
1: ENTERED DATE ONLY
2: ENTERED DATE OR LATER
3: ANY DATE/SCROLL
ENTER SELECTION (1-3):1
ENTER EFFECTIVE DATE: (MM/DD/YY):10/21/86
```

Screen 6

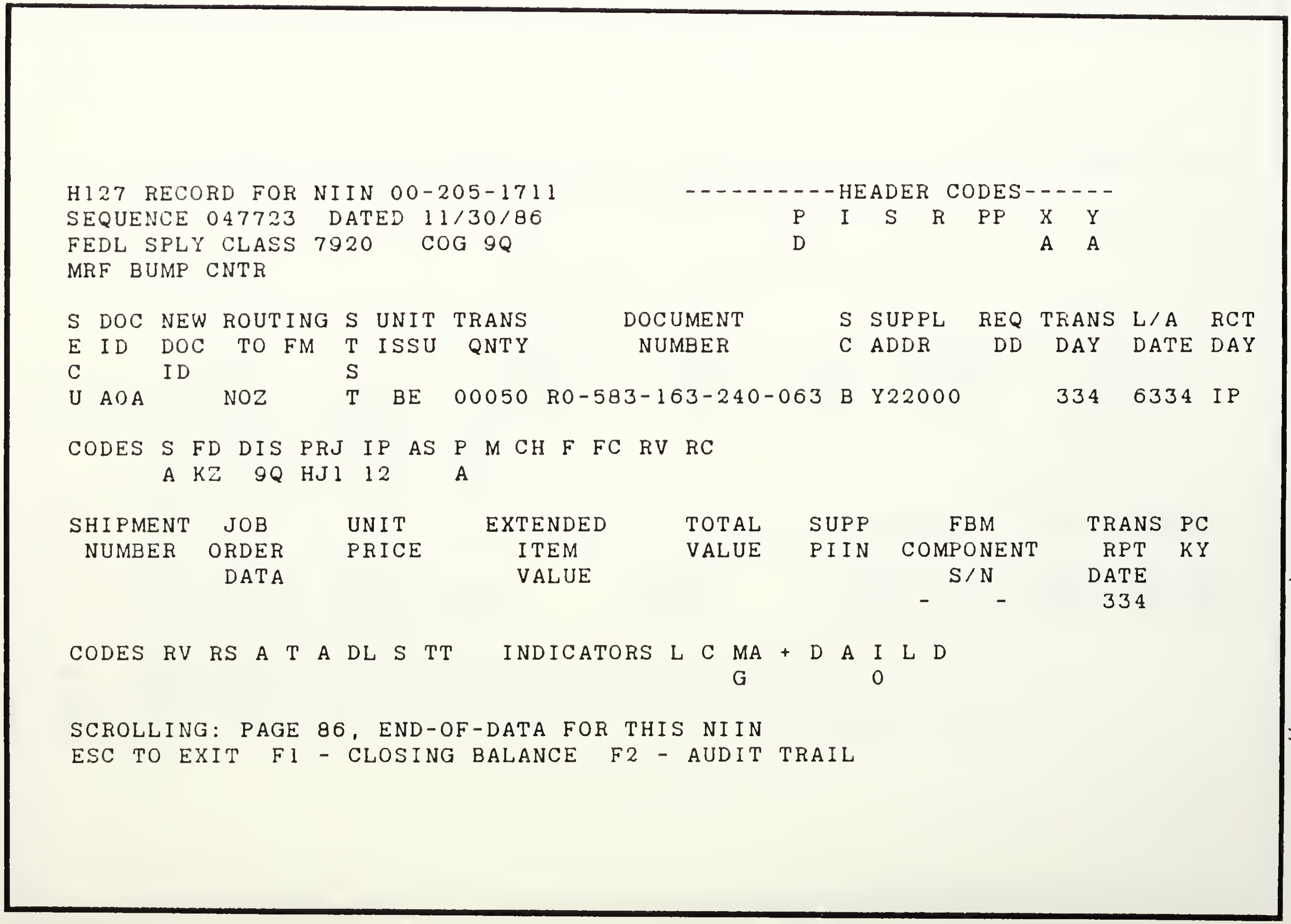
TLOCD TRANSACTION WITH DATE ENTERED
(H127 TRANSACTION RESULTS)



```
H127 RECORD FOR NIIN 00-205-1711        ----------HEADER CODES------
SEQUENCE 033802  DATED 10/21/86                P  I  S  R  PP  X  Y
FEDL SPLY CLASS 7920   COG 9Q                  D               A  A
MRF BUMP CNTR

S DOC NEW ROUTING S UNIT TRANS      DOCUMENT      S SUPPL  REQ TRANS L/A  RCT
E ID  DOC   TO FM T ISSU  QNTY       NUMBER       C ADDR    DD  DAY  DATE DAY
C     ID          S
U AOA      NOZ    S   BE 00036 NO-022-862-940-1WZ   N99922       294  6290 BA

CODES S FD DIS PRJ IP AS P M CH F FC RV RC
      K 1H  9Q      12    A R    F M3

SHIPMENT  JOB     UNIT     EXTENDED     TOTAL   SUPP     FBM       TRANS PC
 NUMBER  ORDER    PRICE      ITEM       VALUE   PIIN  COMPONENT     RPT  KY
          DATA               VALUE                       S/N        DATE
                  $ 1969    $ 70884                   -    -         294

CODES RV RS A T A DL S TT   INDICATORS L C MA + D A I L D
                                           G  M     0 2

PAGE 1, END-OF-DATA
ESC TO EXIT  F1 - CLOSING BALANCE  F2 - AUDIT TRAIL  F3 - SCROLL TRANSACTIONS
```

Screen 7

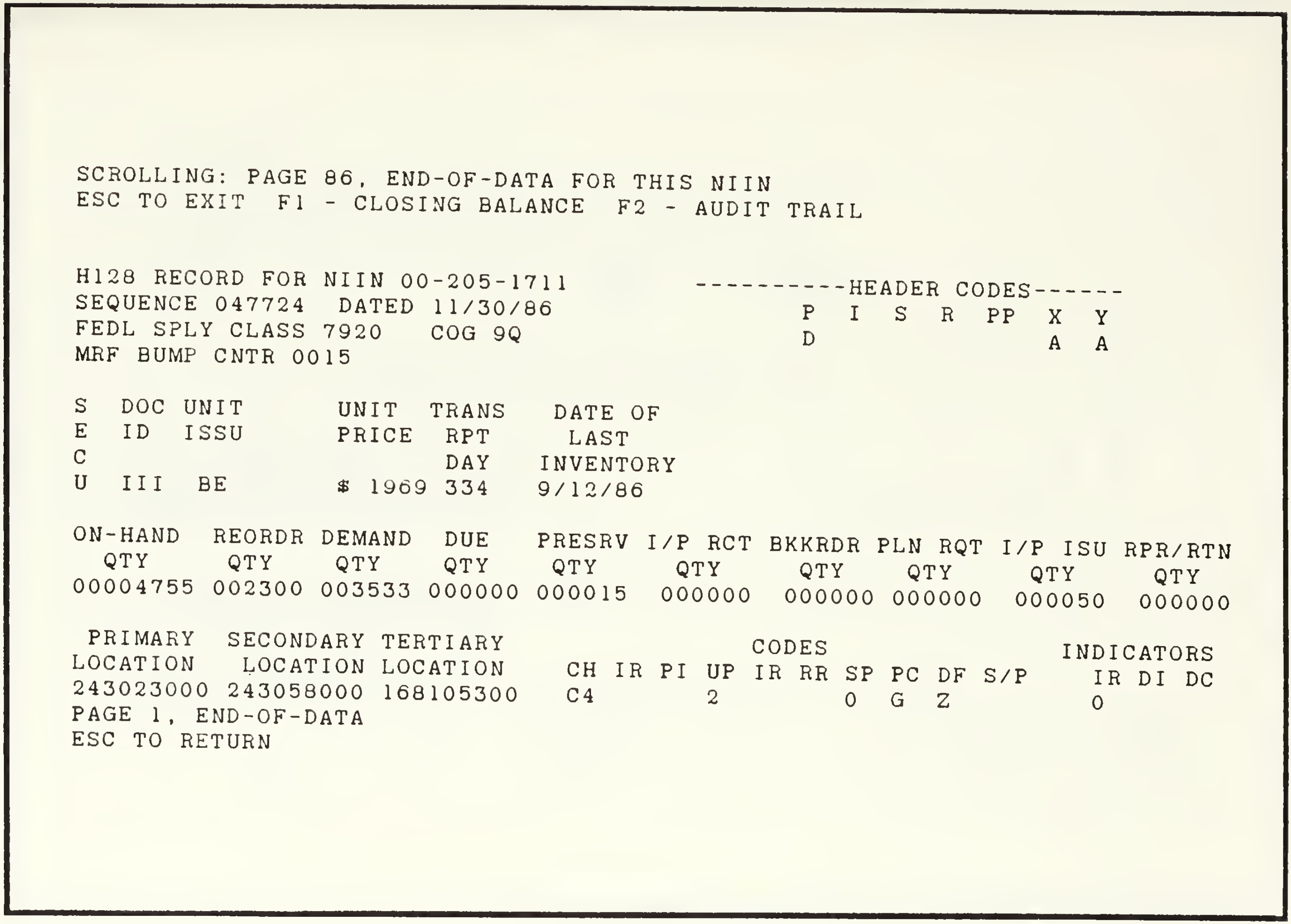
TLOCD TRANSACTION WITH DATE ENTERED
(H127 TRANSACTION RESULTS (SCROLLING))



```
H127 RECORD FOR NIIN 00-205-1711        ----------HEADER CODES------
SEQUENCE 047723  DATED 11/30/86                P  I  S  R  PP  X  Y
FEDL SPLY CLASS 7920   COG 9Q                  D               A  A
MRF BUMP CNTR

S DOC NEW ROUTING S UNIT TRANS      DOCUMENT      S SUPPL  REQ TRANS L/A  RCT
E ID  DOC  TO FM  T ISSU  QNTY       NUMBER       C ADDR    DD  DAY  DATE DAY
C      ID         S
U AOA     NOZ     T  BE  00050 R0-583-163-240-063 B Y22000       334  6334 IP

CODES S FD DIS PRJ IP AS P M CH F FC RV RC
      A KZ  9Q HJ1 12     A

SHIPMENT  JOB     UNIT     EXTENDED     TOTAL   SUPP     FBM      TRANS PC
 NUMBER  ORDER    PRICE      ITEM       VALUE   PIIN  COMPONENT    RPT  KY
          DATA               VALUE                       S/N      DATE
                                                       -    -      334

CODES RV RS A T A DL S TT   INDICATORS L C MA + D A I L D
                                           G        0

SCROLLING: PAGE 86, END-OF-DATA FOR THIS NIIN
ESC TO EXIT  F1 - CLOSING BALANCE  F2 - AUDIT TRAIL
```

Screen 8

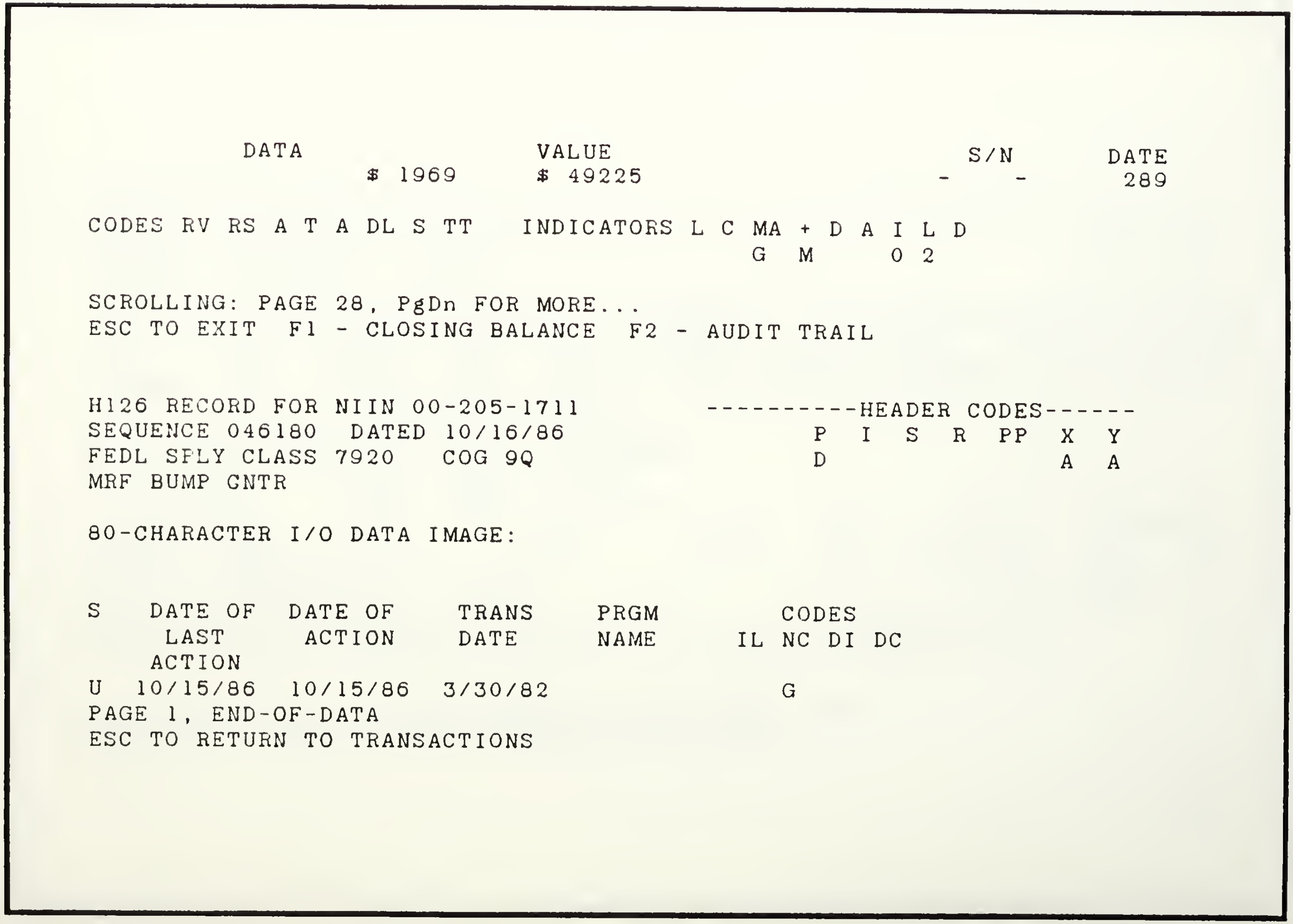
TLOCD TRANSACTION WITH DATE ENTERED
(H128 CLOSING BALANCE RESULTS)



```
SCROLLING: PAGE 86, END-OF-DATA FOR THIS NIIN
ESC TO EXIT  F1 - CLOSING BALANCE  F2 - AUDIT TRAIL


H128 RECORD FOR NIIN 00-205-1711       ----------HEADER CODES------
SEQUENCE 047724  DATED 11/30/86              P  I  S  R  PP  X  Y
FEDL SPLY CLASS 7920   COG 9Q                D                A  A
MRF BUMP CNTR 0015

S  DOC UNIT      UNIT  TRANS   DATE OF
E  ID  ISSU      PRICE  RPT     LAST
C                       DAY   INVENTORY
U  III  BE       $ 1969 334   9/12/86

ON-HAND  REORDR DEMAND  DUE   PRESRV I/P RCT BKKRDR PLN RQT I/P ISU RPR/RTN
  QTY     QTY    QTY    QTY    QTY     QTY    QTY     QTY     QTY     QTY
00004755 002300 003533 000000 000015  000000 000000 000000  000050  000000

 PRIMARY  SECONDARY TERTIARY                 CODES               INDICATORS
LOCATION   LOCATION LOCATION   CH IR PI UP IR RR SP PC DF S/P     IR DI DC
243023000 243058000 168105300  C4       2        0  G  Z           0
PAGE 1, END-OF-DATA
ESC TO RETURN
```

Screen 9

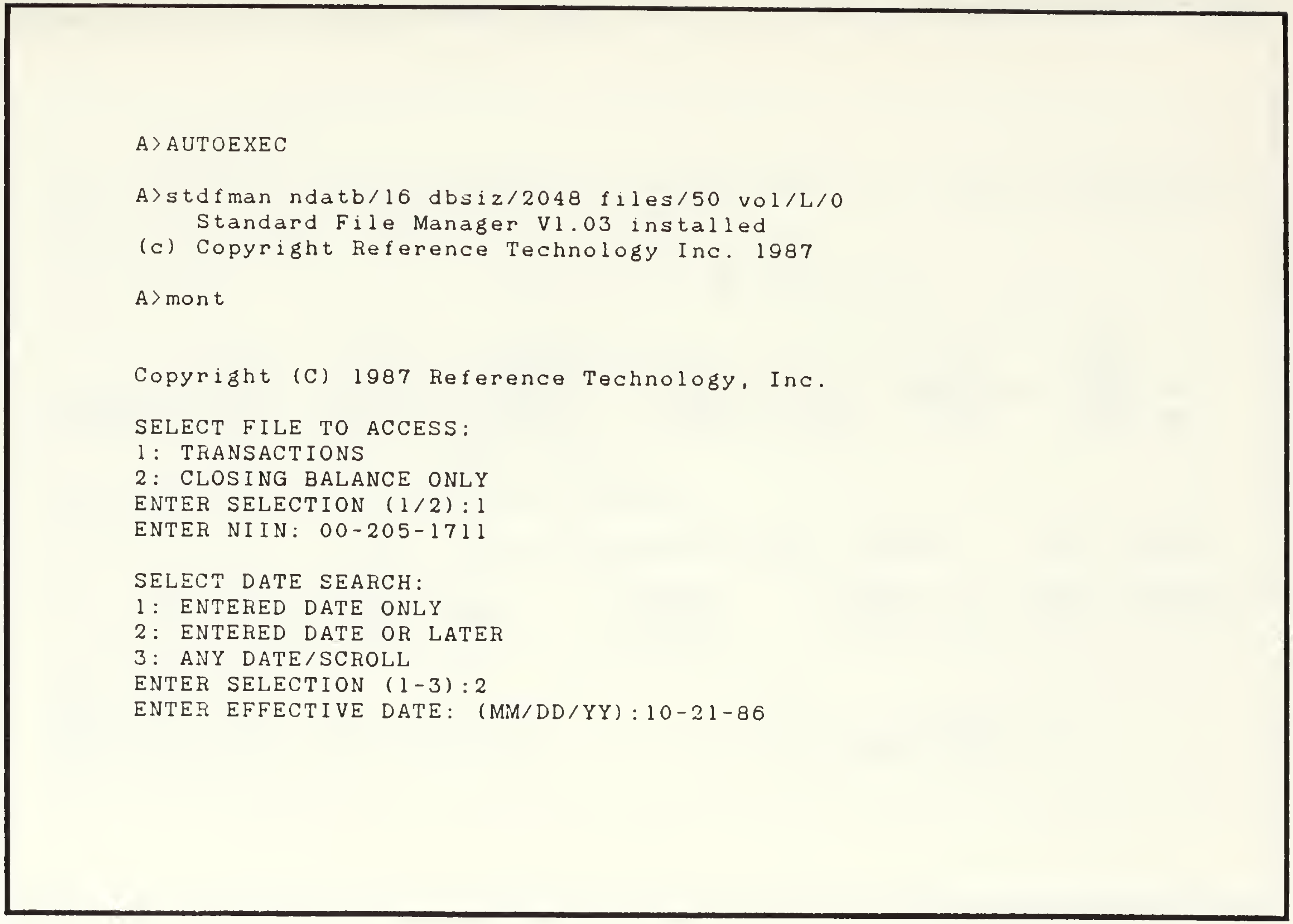
TLOCD TRANSACTION WITH DATE ENTERED
(H126 AUDIT TRAIL RESULTS)



```
          DATA               VALUE                      S/N      DATE
                  $ 1969     $ 49225                   -    -     289

CODES RV RS A T A DL S TT   INDICATORS L C MA + D A I L D
                                           G  M     0 2

SCROLLING: PAGE 28, PgDn FOR MORE...
ESC TO EXIT  F1 - CLOSING BALANCE  F2 - AUDIT TRAIL


H126 RECORD FOR NIIN 00-205-1711        ----------HEADER CODES------
SEQUENCE 046180  DATED 10/16/86                P  I  S  R  PP  X  Y
FEDL SPLY CLASS 7920   COG 9Q                  D               A  A
MRF BUMP CNTR

80-CHARACTER I/O DATA IMAGE:


S   DATE OF  DATE OF    TRANS    PRGM        CODES
     LAST     ACTION    DATE     NAME     IL NC DI DC
    ACTION
U  10/15/86  10/15/86  3/30/82               G
PAGE 1, END-OF-DATA
ESC TO RETURN TO TRANSACTIONS
```

Screen 10

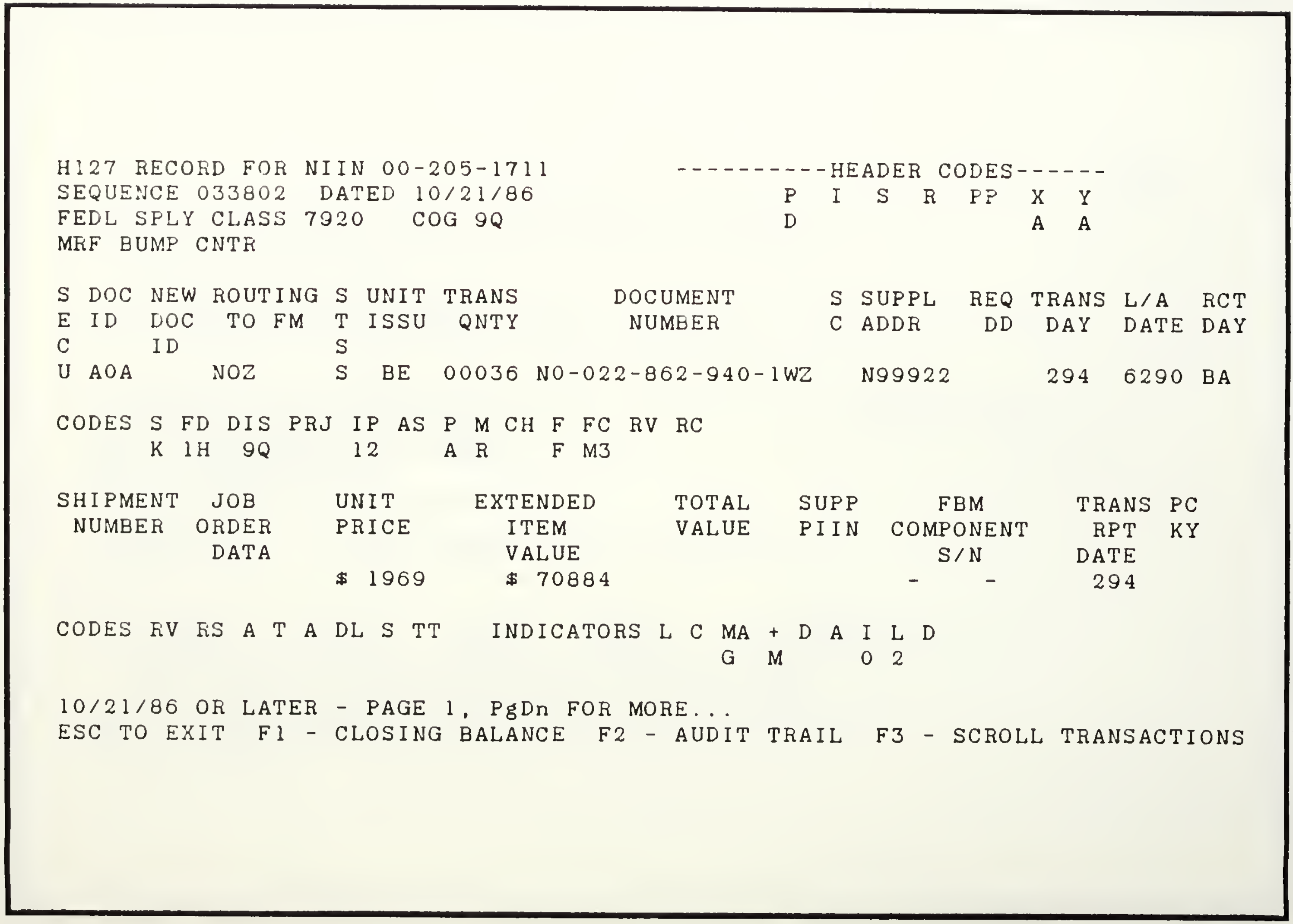
TLOCD TRANSACTION WITH DATE OR LATER SELECTED & ENTERED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN: 00-205-1711

SELECT DATE SEARCH:
1: ENTERED DATE ONLY
2: ENTERED DATE OR LATER
3: ANY DATE/SCROLL
ENTER SELECTION (1-3):2
ENTER EFFECTIVE DATE: (MM/DD/YY):10-21-86
```

Screen 11

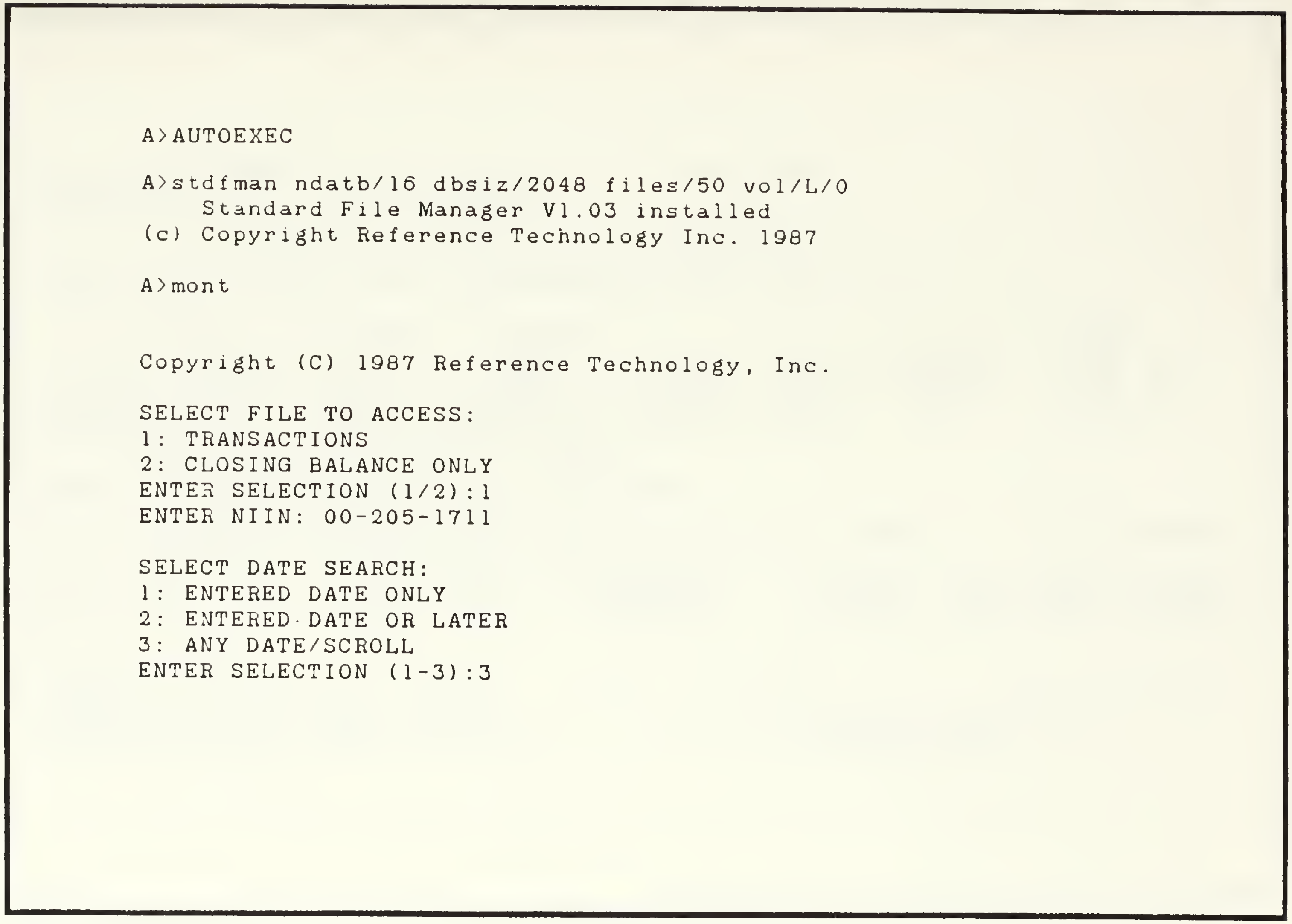
TLOCD TRANSACTION WITH DATE OR LATER SELECTED
& ENTERED (H127 TRANSACTION RESULTS)



```
H127 RECORD FOR NIIN 00-205-1711        ----------HEADER CODES------
SEQUENCE 033802  DATED 10/21/86                 P  I  S  R  PP  X  Y
FEDL SPLY CLASS 7920   COG 9Q                   D               A  A
MRF BUMP CNTR

S DOC NEW ROUTING S UNIT TRANS      DOCUMENT       S SUPPL  REQ TRANS L/A  RCT
E ID  DOC  TO FM  T ISSU  QNTY       NUMBER        C ADDR    DD  DAY  DATE DAY
C     ID          S
U AOA     NOZ     S  BE  00036 N0-022-862-940-1WZ    N99922      294  6290 BA

CODES S FD DIS PRJ IP AS P M CH F FC RV RC
      K 1H  9Q     12     A R    F M3

SHIPMENT  JOB     UNIT     EXTENDED     TOTAL   SUPP      FBM      TRANS PC
 NUMBER  ORDER    PRICE      ITEM       VALUE   PIIN   COMPONENT    RPT  KY
          DATA               VALUE                        S/N      DATE
                  $ 1969     $ 70884                    -    -      294

CODES RV RS A T A DL S TT   INDICATORS L C MA + D A I L D
                                            G  M     0 2

10/21/86 OR LATER - PAGE 1, PgDn FOR MORE...
ESC TO EXIT  F1 - CLOSING BALANCE  F2 - AUDIT TRAIL  F3 - SCROLL TRANSACTIONS
```

Screen 12

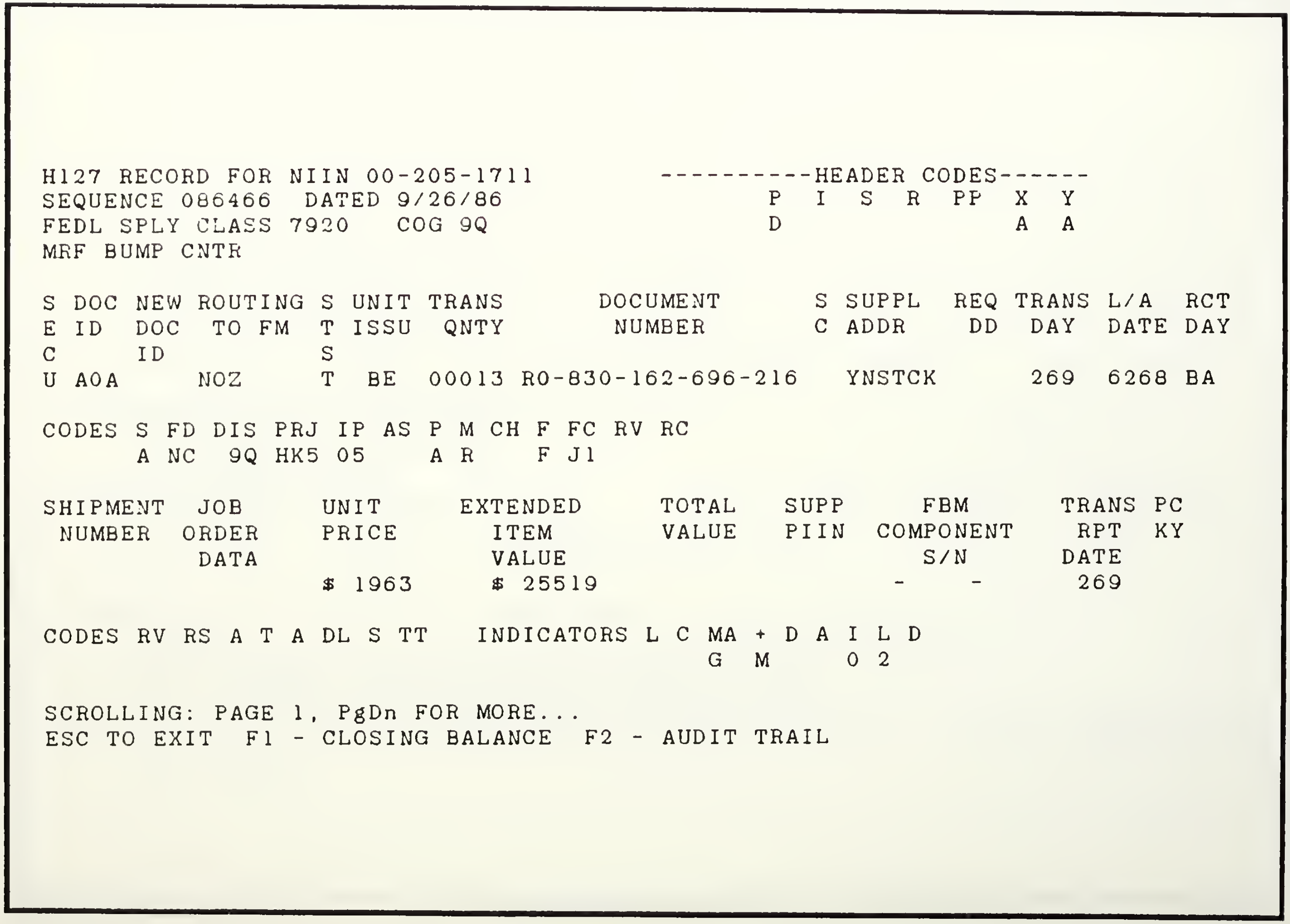
TLOCD TRANSACTION WITH ANY DATE / SCROLL SELECTED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):1
ENTER NIIN: 00-205-1711

SELECT DATE SEARCH:
1: ENTERED DATE ONLY
2: ENTERED DATE OR LATER
3: ANY DATE/SCROLL
ENTER SELECTION (1-3):3
```

Screen 13

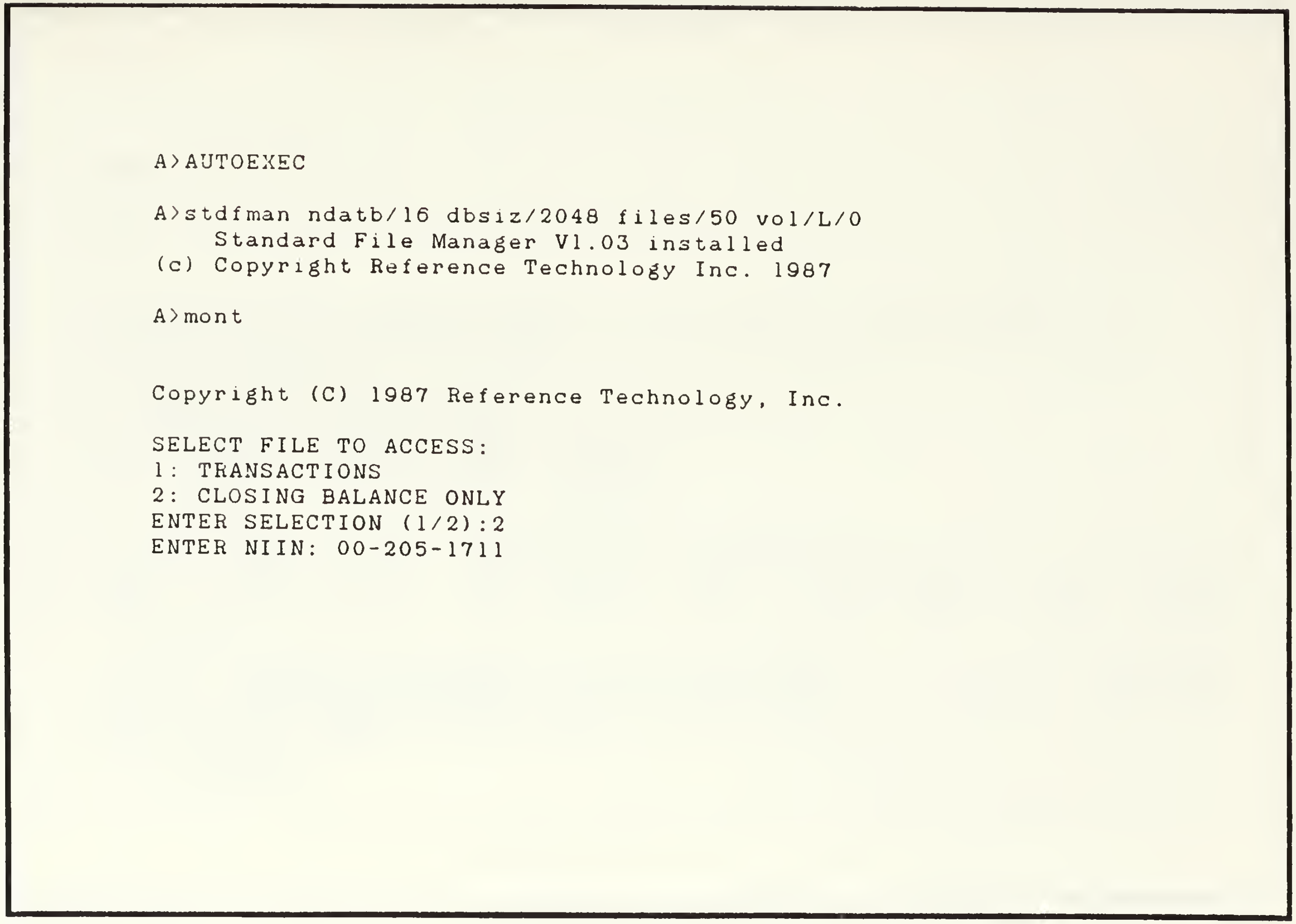
TLOCD TRANSACTION WITH ANY DATE / SCROLL SELECTED
(H127 TRANSACTION RESULTS)



```
H127 RECORD FOR NIIN 00-205-1711        ----------HEADER CODES------
SEQUENCE 086466  DATED 9/26/86                  P  I  S  R  PP   X  Y
FEDL SPLY CLASS 7920   COG 9Q                   D                A  A
MRF BUMP CNTR

S DOC NEW ROUTING S UNIT TRANS     DOCUMENT      S SUPPL  REQ TRANS L/A  RCT
E ID  DOC  TO FM  T ISSU  QNTY      NUMBER       C ADDR    DD  DAY  DATE DAY
C     ID          S
U AOA     NOZ     T  BE  00013 R0-830-162-696-216  YNSTCK       269  6268 BA

CODES S FD DIS PRJ IP AS P M CH F FC RV RC
      A NC  9Q HK5 05    A R    F J1

SHIPMENT  JOB     UNIT     EXTENDED     TOTAL   SUPP     FBM       TRANS PC
 NUMBER  ORDER    PRICE      ITEM       VALUE   PIIN  COMPONENT     RPT  KY
          DATA               VALUE                       S/N        DATE
                  $ 1963     $ 25519                   -    -        269

CODES RV RS A T A DL S TT   INDICATORS L C MA + D A I L D
                                           G  M     0 2

SCROLLING: PAGE 1, PgDn FOR MORE...
ESC TO EXIT  F1 - CLOSING BALANCE  F2 - AUDIT TRAIL
```

Screen 14

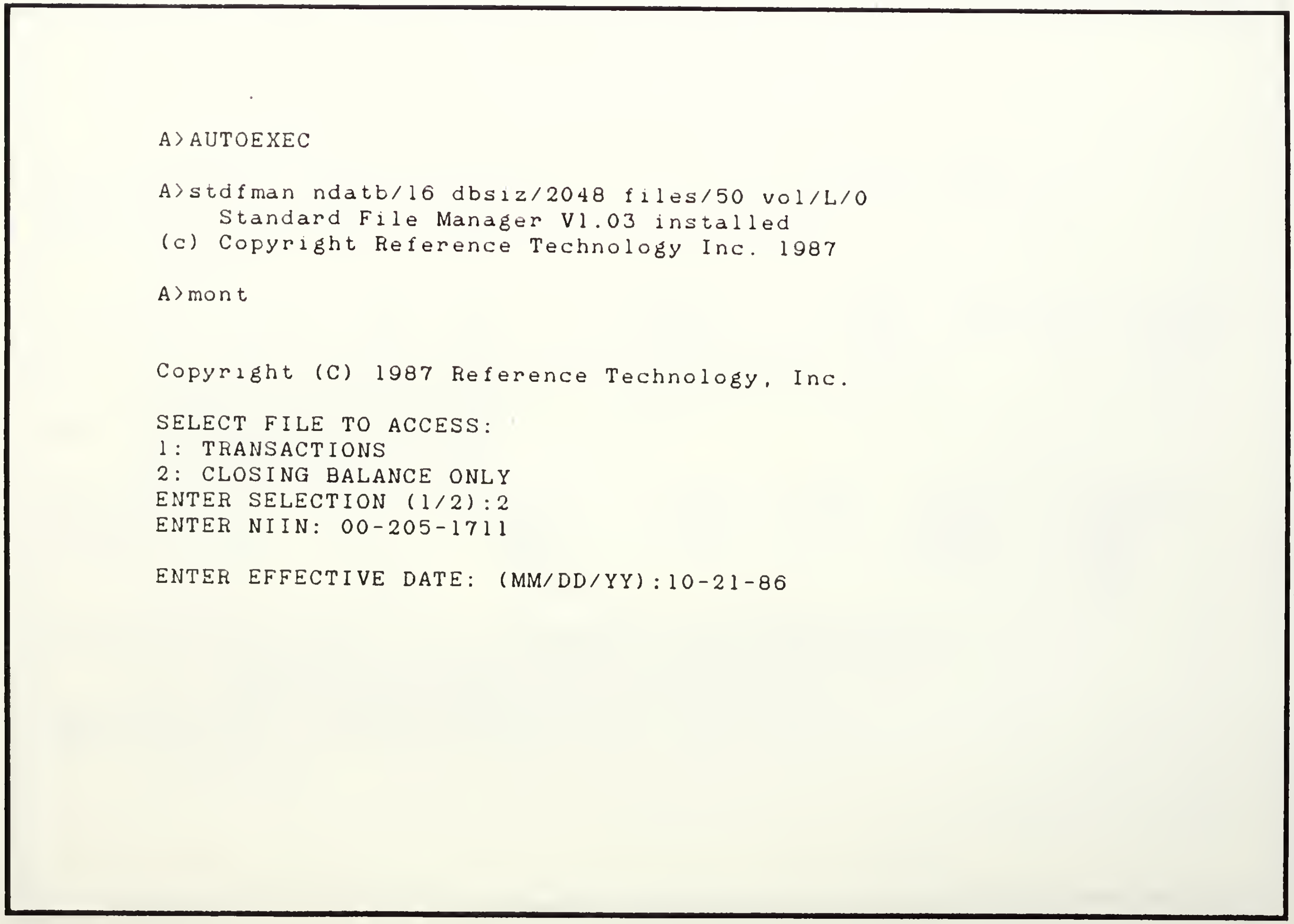
TLOCD MAIN MENU WITH CLOSING BALANCE ONLY SELECTED



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):2
ENTER NIIN: 00-205-1711
```

Screen 15

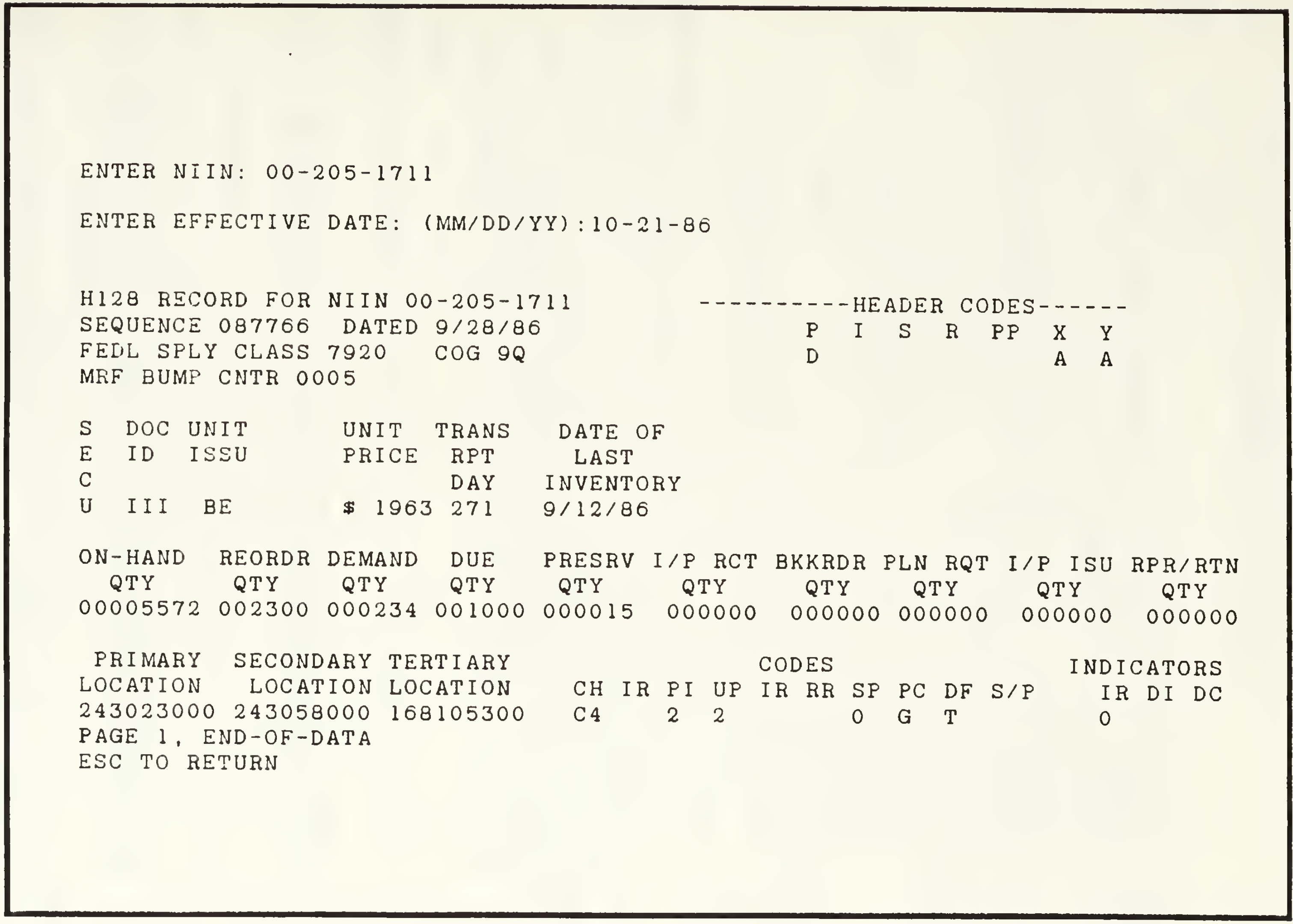
TLOCD MAIN MENU WITH CLOSING BALANCE ONLY SELECTED
(AND DATE ENTERED)



```
A>AUTOEXEC

A>stdfman ndatb/16 dbsiz/2048 files/50 vol/L/0
    Standard File Manager V1.03 installed
(c) Copyright Reference Technology Inc. 1987

A>mont


Copyright (C) 1987 Reference Technology, Inc.

SELECT FILE TO ACCESS:
1: TRANSACTIONS
2: CLOSING BALANCE ONLY
ENTER SELECTION (1/2):2
ENTER NIIN: 00-205-1711

ENTER EFFECTIVE DATE: (MM/DD/YY):10-21-86
```

Screen 16

TLOCD MAIN MENU WITH CLOSING BALANCE ONLY SELECTED
(AND DATE ENTERED) (H128 CLOSING BALANCE RESULTS)



```
ENTER NIIN: 00-205-1711

ENTER EFFECTIVE DATE: (MM/DD/YY):10-21-86


H128 RECORD FOR NIIN 00-205-1711         ----------HEADER CODES------
SEQUENCE 087766  DATED 9/28/86                  P  I  S  R  PP  X  Y
FEDL SPLY CLASS 7920   COG 9Q                   D                A  A
MRF BUMP CNTR 0005

S  DOC UNIT      UNIT  TRANS   DATE OF
E  ID  ISSU      PRICE  RPT     LAST
C                       DAY   INVENTORY
U  III  BE       $ 1963 271   9/12/86

ON-HAND  REORDR DEMAND  DUE   PRESRV I/P RCT BKKRDR PLN RQT I/P ISU RPR/RTN
  QTY     QTY    QTY    QTY    QTY     QTY     QTY    QTY     QTY     QTY
00005572 002300 000234 001000 000015  000000  000000 000000  000000  000000

 PRIMARY  SECONDARY TERTIARY                 CODES                INDICATORS
LOCATION   LOCATION LOCATION   CH IR PI UP IR RR SP PC DF S/P      IR DI DC
243023000 243058000 168105300  C4     2  2        0  G  T           0
PAGE 1, END-OF-DATA
ESC TO RETURN
```

Screen 17

GLOSSARY

ANSI--American National Standards Institute

Application Development--Customer software developed according to the user's specification that can include user interface, data presentation and integration of the information product into existing applications.

ASCII--American Standard Code for Information Interchange. It is the standard table of 7-bit digital representations used to transmit information to a printer, other computers, or other peripheral devices.

ASIC--Application Specific Integrated Circuits.

Bit--Binary digit. The smallest part of information in binary notation. A bit is written as either 1 or 0 and represents either the on or off variation of voltage.

Board--A printed-circuit board, or card, that mounts onto the physical chassis of a computer or peripheral and holds the chips and associated wiring. Other cards may be plugged into this board.

Boot--The process of initializing an operating system on a computer.

Bootstrap--The program used by the computer to load the operating system.

Break--The process of interrupting and temporarily halting a sequence of operations.

Buffer--An auxiliary storage area for data. Many peripherals have buffers used to temporarily store data that will be used as time permits.

Byte--A group of eight bits of digital data which is processed together. A byte can have 256 (or 2^8) possible combinations of 8 binary digits.

Cache--Fast RAM. (See also RAM).

CALS--Computer-Aided Logistics Support.

Card--See Board.

CATIS--Computer-Aided Technical Information System. A Navsea project involved with placing engineering technical diagrams and manuals on optical disc.

CAV--Constant Angular Velocity. A technique that spins a disc at a constant speed, resulting in the inner disc tracks passing the read/write head more slowly that the outer tracks. this results in numerous tracks forming concentric circles with the storage density being the greatest on the inner track. (See also CLV).

CCITT--Acronym for the French name of the Consultive Committee on International Telephone and Telegraph. CCITT issues the standards for data compression techniques such as CCITT Group 3.

CD--Compact Disc - See CD-ROM

CDI--Compact Disc Interactive. Physically identical to the CD-ROM disc, however, with emphasis on the interactive presentation of video, audio, text and data. A self-contained multimedia system expected to operate in conjunction with home entertainment equipment.

CD ROM--See CD-ROM

CDROM--See CD-ROM

CD-ROM--Compact Disc - Read Only Memory. A computer peripheral capable of storing large amounts of data which are placed on the disc at the time of manufacture.

Checksum--A method of checking the accuracy of a character transmitted, manipulated, or stored. The checksum is the result of the summation of all the digits involved. Used for error detection vice error correction.

Chip--The term applied to an integrated circuit that contains many electronic circuits. A chip is sometimes called an IC or an IC chip. The name is occasionally applied to the entire integrated circuit package.

CIRC--Cross-Interleaved Reed-Solomon Code. The only error correction scheme used with CD Audio, and the first layer used with CD-ROM. It is implemented in the hardware, and uses two independent R-S codes to achieve an error rate of 1 uncorrected error per 10^9 bytes.

CLV--Constant Linear Velocity (as opposed to CAV). Used with CD-ROM to keep the data moving past the optical head at a constant rate. In order to accomplish this, the rotational speed of the disc must vary, decreasing as the head moves from the inner tracks toward the outer perimeter. The range is approximately 500 to 200 rpm for a CD-ROM disc drive.

Code--A method of representing data in a form the computer can understand and use.

Command--A code that represents an instruction for the computer.

CRC--Cyclic Redundancy Code. ECC algorithm for the checking of CD-ROM after error correction is performed--only capable of error detection.

DataPlate--A proprietary name given to a CD-ROM by Reference Technology, Inc..

Density--The closeness of space distribution on a storage medium such as a disc.

Disk Operating System--DOS. A program or programs that provide basic utility operations and control of a disk-based computer system.

Disc Preparation--Providing certified tapes and shipping containers for customer data. Scanning input tapes for data integrity and cleaning up minor problems, building a directory (High Sierra or customer), putting the data in proper format for the mastering center user.

DMA--Direct Memory Access.

DOS--See Disk Operating System.

Double-Density--This term is most often applied to the storage characteristics of disks, and generally refers to the density of the storage of bits on the disk surface on each track.

DRAW--Direct Read After Write. A write once optical disc technology (See also WORM), an error control technique; however, it is unable to be used with CD-ROM.

EBCDIC--Extended Binary Coded Decimal Interchange Code. An 8-bit code developed by IBM, and used primarily by IBM and its compatibles. The code is used to represent 256 numbers, letters and characters in a computer system. (See also ASCII)

ECC--Error Correction Coding. The application or addition of redundant data to the original data in order to provide a means of correction when an error in the original data is detected.

EDC--Error Detection Code. The application of redundant data to the original data in order to detect errors.

EDAC--Error Detection and Correction. Redundant information which is calculated according to certain algorithms used to detect and correct errors when data is read.

EDMICS--Engineering Data Management Information Control System--A NAVSUP project.

FCCSSAT--Federal Council On Computer Storage Standards and Technology.

GB--See Gigabyte.

Gbyte--See Gigabyte.

Giga--1,000,000,000.

Gigabyte--1,000 megabytes, or 1 billion (10^9) bytes.

Glass Master--The original glass disc upon which the digital information is burned with a laser. From it are formed the "stampers" which in turn are used to produce the numerous discs, usually by an injection molding process.

Hardware--The physical computer and all of its component parts, as well as any peripherals and interconnecting cables.

Head Crash--When the read-head contacts the magnetic surface of the disk--a highly undesirable occurrence.

High Sierra Group--An ad hoc working group of CD-ROM service companies, vendors, and manufacturers which has been a prime source of activity in the setting of standards for CD-ROM data format and compatibility. The group was named after its first meeting place--the High Sierra Hotel at Lake Tahoe. The group first met in 1985.

IC--Integrated Circuit.

Indexing--The actual processing of all records according to the layout and the building of the index file. Indexes permit the computer to rapidly locate data without searching through the full body of data. Generally, a data item is searchable only if it is indexed.

Indexing Layout--Design of the customer database according to the criteria established by the customer. This is done only when the database is first processed or changes are made.

Indexing Set Up--Tape handling, resource allocation and loading the layout programs on the indexing system.

Instruction--A program step that tells the computer what to do for a single operation in a program.

Interface--A device that serves as a common boundary between two other devices, such as two computer systems or a computer and peripheral.

Interweaving--A technic used to physically disperse data for each code over a larger area of media in order to spread error bursts over multiple code words, thus minimizing the error caused to any one code by a long defect.

Jewel Box--The plastic container in which the CD-ROM disc is generally stored.

Jukebox--See Optical Jukebox.

K--Abbreviation for Kilo.

KB--See Kilobyte.

Kbyte--See Kilobyte.

Kilo--A prefix meaning (1) 1000 when used in a mathematical expression; or (2) 1,024 2^{10} when used as a unit measure in computers. As an example, 16K would equal 16 times 1,024 or 16,384.

Kilobyte--A unit of measure in computers that equals 1024 bytes.

LAN--Local Area Network.

Land--The reflective area between two adjacent non-reflective pits on a disc. The transition from pit to land or land to pit represents a binary 1. (See also Run).

Layered ECC--The second level of correction performed by the host computer's software.

Load--The process of entering information (data or program) into a computer, from a keyboard, disk, or other source.

M--Abbreviation for Mega.

Machine Language--A programming language consisting only of numbers or symbols (binary code) that the computer can understand without translation.

Magneto-Optic--A form of erasable media that stores information in the form of vertically oriented magnetic domains.

Mastering--The entire process involving the scheduling of the mastering center, managing artwork and packaging issues and Q.A.ing all replicas for data integrity and readability.

MB--See Megabyte.

Mbyte--See Megabyte.

Mega--1,000,000.

Megabyte--1,000 Kilobytes, or 1 million (10^6) bytes.

Metal Mother--The negative mold created from the glass master which is in turn used to stamp the numerous discs. Often called a "stamper".

Millisecond--One 1/1,000th of a second.

Micron--One square micron, the area occupied by 1 bit on a CD-ROM. One millionth of a meter.

Microsecond--One 1/1,000,000th of a second.

MO--See Magneto-Optic.

MS-DOS--The disk operating system used with IBM computers and their compatibles.

NISO--National Information Standards Organization.

NSC--Naval Supply Center

NSTIS--Navy Standard Technical Information System.

OCR--Optical Character Recognition. Generally used in reference to a device capable of scanning printed material into a digital form.

OD3--Optical Digital Data Disc

Optical Jukebox--A store and read mechanism capable of storing and accessing multiple CD-ROMs. Accessing is generally accomplished by mechanical means after which the discs are placed on a single reader (disc drive) for use.

OROM--Optical Read Only Memory

Pit--The microscopic depression in the reflective surface of a disc. The pattern of pits represents the data being stored on the disc. (See also "land"). The light from the laser used to read the data is reflected back from the lands, but scattered by the pits. A typical pit as about the size of a bacterium - 0.5 by 2.0 microns.

Pixel--A picture element in a video display; the minimum raster display element, represented as a point with a specified color and intensity.

Platter--Generally used in reference to the larger (12") optical discs. Sometimes in reference to a single layer in a magnetic disc pack.

RAM--Random Access Memory. Semiconductor memory circuits used to store data and programs in information processing systems.

RS--See Reed-Solomon.

Reed-Solomon Codes--A family of error correction codes capable of correcting single and multiple random symbol errors. Used with CD-ROM and CD Audio. (See also CIRC)

R/W/E--/Read/Write/Erase--An alternative title for erasable discs.

Run--The distance between transitions either from land to pit or pit to land. The distance represents two or more zeros (See also Land).

SASI--Shugart Associated System Interface--The precursor to SCSI.

SCSI--Small Computer Systems Interface--A complete 8-bit parallel interface bus structure with rates up to 4 Mbytes/sec. that is subordinate to the rest of the system architecture. Up to 8 systems and peripherals may be connected to the same bus.

Soft-Sectored--This term applies to disks and indicates a type of disk that has a single timing hole which marks the beginning of a track. Sectoring of the track is controlled by software.

Software--A general term that applies to any program (set of instructions) that can be loaded into a computer from any source.

Sort--To arrange (or place in order) data according to a predefined set of rules.

Stamper--See Metal Mother

Substrate--The base material form which a disc is made, generally a strong and transparent polycarbonate plastic.

Track--A linear, spiral or circular path on which information is placed, or found. The portion of a disk that one read/write head passes over to extract data. Track density is measured in tpi (tracks per inch).

Tbyte--Terabyte or 1,000 gigabytes. (10^{12}).

TLOCD--Transaction Ledger On Compact Disc (pronounced "T-locked") Acronym created by author to identify new product. Same information as TLOD, however it is resident on a 4.72 inch compact disc. (See also TLOD).

TLOD--Transaction Ledger On Disc (pronounced "T-load") a record of the all the UADPS-SP transactions executed at a specific Naval Supply Center.

TMO--Thermo-Magneto-Optic. See Magneto-Optic.

UADPS-SP--Uniform Automated Data Processing System - Stock Point. An automated system that coordinates all the logistics control, financial management, inventory, ordering, issuing, buying, et cetera for Navy stock points. TLOD functions as a subset of this overall system.

Vaporware--Hardware that is generally still in the lab which has not sufficiently been demonstrated or proven to actually be a product.

WORM--Write Once Read Many (occasionally seen as Write Once Read "Mostly" or "Multiple").

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